Anritsu

OPERATION MANUAL

NETWORK/SPECTRUM ANALYZER

MS560J

ANRITSU CORP.

1985.10 x 60 NIV-4(Y)
Printed in Japan

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Table 2-1 Front Panel

	No.	General description	Details
DISPLAY	①	SCREEN	2.7
	②	MEMORY: PBM receptacle and operation indicator lamp	2.8 – (40)
	③	POWER: Power switch	2.8 – (1)
	④	UNCAL: Misoperation indication lamp	2.8 – (2)
	⑤	STANDBY: Standby indicator	
	⑥	OUTPUT: Synthesizer output switching key	2.8 – (3)
	⑦	INPUT: Input terminal impedance indicator, overload indicator.	2.8 – (4) 2.8 – (5)
	⑧	TRACE: Can set the following measurement functions: MAGNITUDE PHASE DELAY MAGNITUDE/PHASE MAGNITUDE/DELAY LEVEL (R) LEVEL (T) SPECT (R) SPECT (T)	2.8 – (6)
	⑨	LIN, EXP: Auxiliary keys for level, spectrum and delay measurements	2.8 – (7) 3.2.5
	⑩	SUB TRACE: Can set the following memory functions: A→B: Copies measured values into B memory. B = A: Displays the same measured values graphically on the screen using a different scale. B = A – B: Subtracts the value in B memory from the measured value and displays the result on the screen.	2.8 – (8) 3.4
	⑪	These keys specify the following items relating to the measured values displayed on the screen. The display conditions are set using knob A ⑫.	
		A-SCALE, OFFSET	2.8 – (13)
		B-SCALE, OFFSET	2.8 – (14)
		MAIN MARKER	2.8 – (10)
		ΔMARKER	2.8 – (11)
		ZERO MARKER	2.8 – (9)
		TRIGGER LEVEL	2.8 – (12)

Table 2-1 Front Panel (Cont'd)

	No.	General description	Details
MEASURE	⑫	Knob A	
	⑬	These keys specify items to set the following measurement conditions. The actual measuring conditions are set by knob B ⑭ or ENTRY keys ⑯.	
		Frequency sweeping mode and frequency range.	2.8 – (15) ~ (17)
		Synthesizer output level	2.8 – (18)
		SWEEP TIME	2.8 – (19)
		INPUT RANGE	2.8 – (20)
		RES BW	2.8 – (21)
		VIDEO BW	2.8 – (22)
		DELAY RANGE	2.8 – (23)
	⑭	Knob B	
	⑮	These keys set the following measurement functions:	
		LEVEL SWEEP	2.8 – (24)
		SIGNAL TRACK	2.8 – (25)
		COUPLED TO FREQ	2.8 – (26)
		COUPLED TO SPAN	2.8 – (27)
		CAL (X - S)	2.8 – (28)
		TRACK ADJ	2.8 – (29)
ENTRY	⑯	ENTRY: is used to set the numerical measuring condition values and the addresses of SAVE and RECALL.	2.8 – (16) Note
CONTROL	⑰	These keys set the following control functions:	
		PTA	2.8 – (30)
		LOCAL	2.8 – (31)
		CAL-INT	2.8 – (32)
		CAL-X→S	2.8 – (33)
		REG/MEMORY	2.8 – (34)
		ADV FUNCTION	2.8 – (35)
		SWEEP	2.8 – (36) ~ (39)
	⑱	Input and output connectors	2.9

Table 2-2 Abbreviation

CRT Display	Front Panel Indication	Meaning
MRK	MAIN MARKER	MAIN MARKER
ΔMRK	ΔMARKER	ΔMARKER
FRQ	–	FREQUENCY COUNT (MARKER FREQUENCY)
MAG	MAGNITUDE	MAGNITUDE
PHA	PHASE	PHASE
DLY	DELAY	DELAY
M/P	M/P	MAGNITUDE/PHASE
M/D	M/D	MAGNITUDE/DELAY
L (R)	LEVEL (R)	LEVEL (R)
L (T)	LEVEL (T)	LEVEL (T)
S (R)	SPECT (T)	SPECTRUM (T)
S (T)	SPECT (T)	SPECTRUM (T)
LIN	LIN	LINEAR
EXP	EXP	EXPAND
VID	–	VIDEO
LIN/EXP	–	LINEAR/EXPAND
VID/EXP	–	VIDEO/EXPAND
dB/	SCALE	dB/DIVISION . . . . . SCALE
deg/	SCALE	deg/DIVISION . . . . . SCALE
nS/	SCALE	nS/DIVISION . . . . . SCALE
⋮	⋮	⋮
ms/	SCALE	ms/DIVISION . . . . . SCALE
CF	CENTER	CENTER FREQUENCY
SPAN	SPAN	SPAN FREQUENCY
START	START	START FREQUENCY
STOP	STOP	STOP FREQUENCY
OUT (A)	OUTPUT (START)	OUTPUT LEVEL or START LEVEL (level sweep)
OUT (B)	OUTPUT-A, B	( ): OUTPUT terminal
STOP	STOP	STOP LEVEL
STEP	STEP	STEP LEVEL
ST	SWEEP TIME	SWEEP TIME
IRG	INPUT RANGE	INPUT RANGE
RBW	RES BW	RESOLUTION BANDWIDTH
VBW	VIDEO BW	VIDEO BANDWIDTH
DR	DELAY RANGE	DELAY RANGE

2.6 REAR PANEL DESCRIPTION

The following Fig. 2-2 and Table 2-3 show the arrangement and functions of the switches and connectors on the rear panel of the MS560J.

Note

Be sure to set the STD switch to INT.

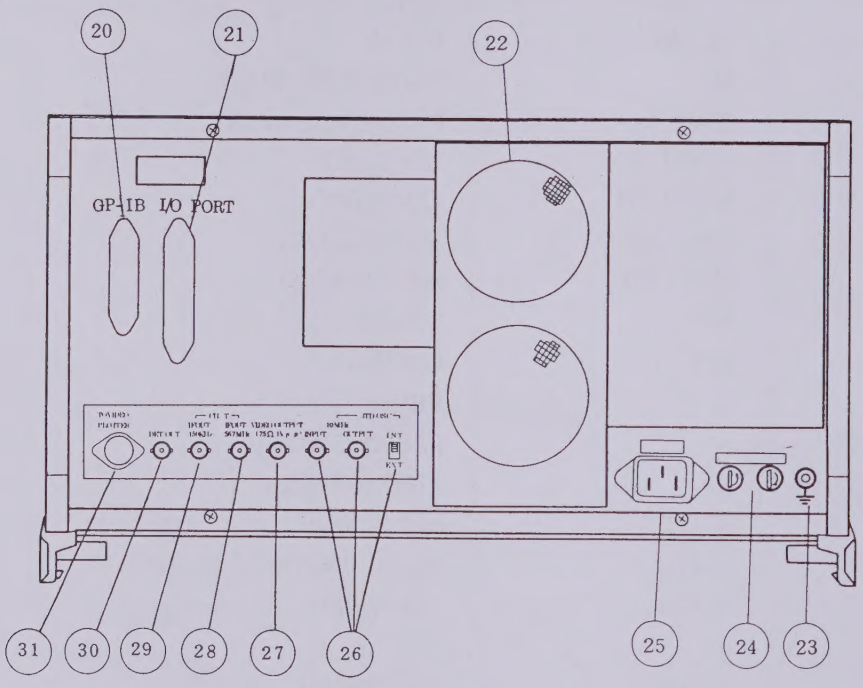


Fig. 2-2 Rear Panel

Table 2-3 Rear Panel

No.	General description		Details
⑳	GP-IB:	Connector for GP-IB	GP-IB OPERATION MANUAL
㉑	I/O PORT:	This I/O connector is used for periphreal controls using the PTA1.	PTA1 OPERATION MANUAL
㉒	Fan		
㉓	⏚ :	This ground terminal protects the user from electric shock.	
㉔	FUSE:	Fuse holder	
㉕	Power cable connector		
㉖	STD OSC:	Reference oscillator (10 MHz) selection switch.	
	OUTPUT:	Output connector of the reference oscillator.	
	INPUT:	Input connector of the reference oscillator.	
㉗	VIDEO OUTPUT: (75 Ω, 1 Vp-p)	Output connector for the video signal. The output voltage is about 1 Vp-p at 75 Ω load.	
㉘	IF OUT: 56.7 MHz	56.7 MHz IF output connector	
㉙	IF OUT: 450 kHz	450 kHz IF output connector	
㉚	DET OUT:	Detector output connector	
㉛	TO VIDEO PLOTTER:	Separate video output Connect to video plotter.	

2.7 SCREEN DISPLAY

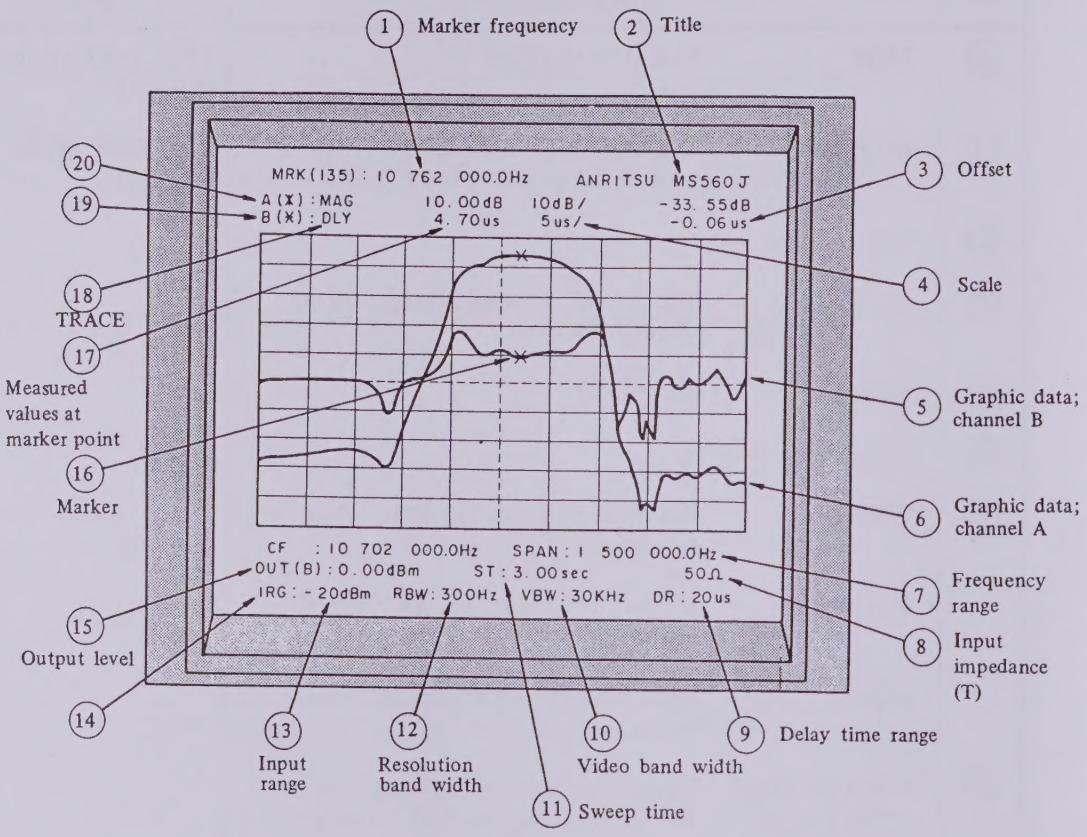


Fig. 2-3 SCREEN Display

(1) TRACE (Measuring items) ⑱

These are displayed at ⑱

Note

Line ⑲ and graphic data ⑤ are displayed only when M/P, M/D, or SUBTRACE is on.

For linear display and video sweep, line (20) is displayed as follows:

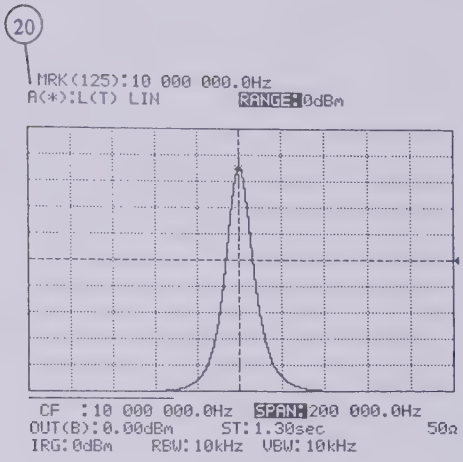


Fig. 2-4 Linear display (LIN)

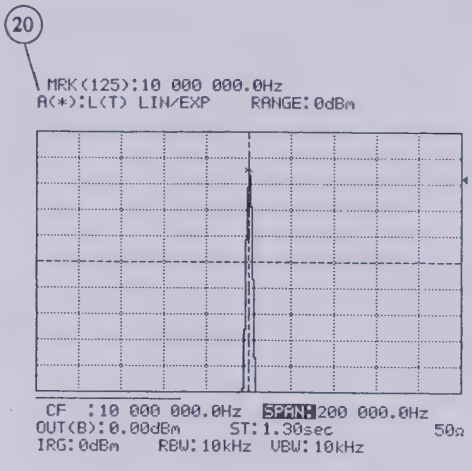


Fig. 2-5 Linear expand display (LIN/EXP)

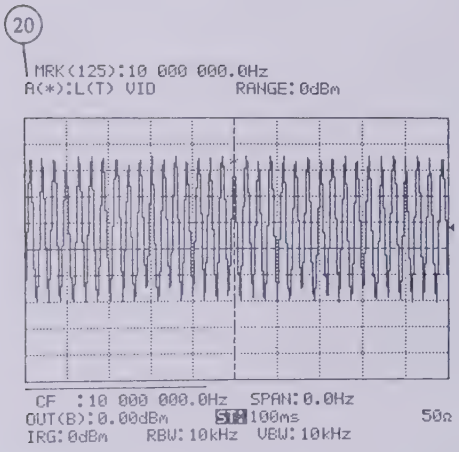


Fig. 2-6 Video sweep (VID)

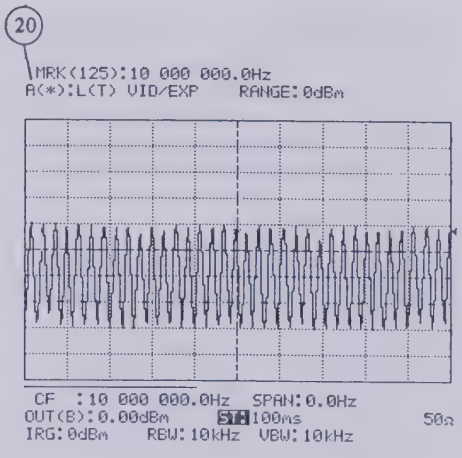


Fig. 2-7 Video expand sweep (VID/EXP)

(7) Output level (15)

This indicates the output level of the synthesizer. The letter in brackets indicates the output port. When [STOP] and [STEP] keys are pushed, STOP and STEP levels are displayed as follows:

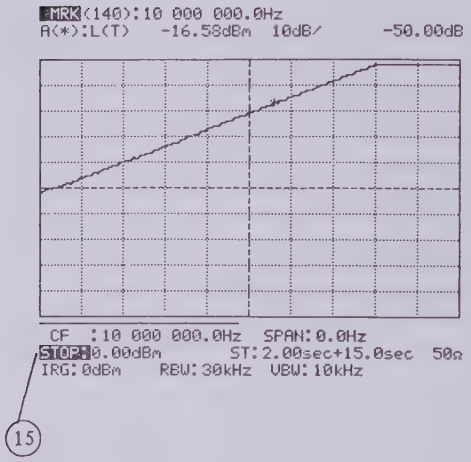


Fig. 2-13 STOP level

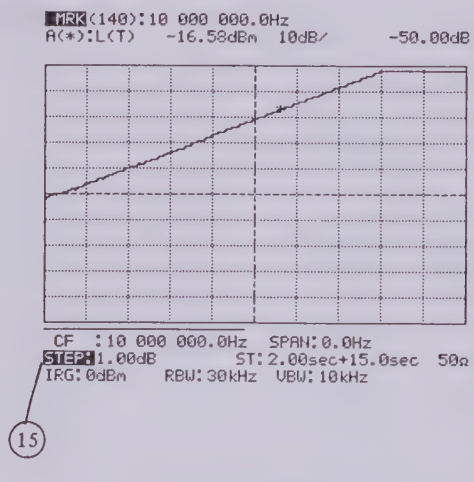


Fig. 2-14 STEP level

(8) Sweep time (11)

This displays the sweep time. The sweep time for level sweep and integration are displayed as follows (adding + 15.0 sec. display):

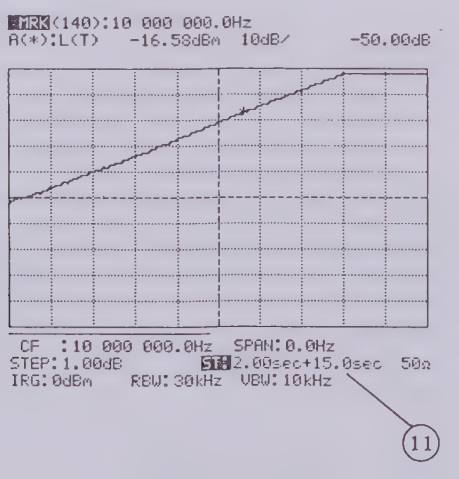


Fig. 2-15 Sweep Time (ST)

(9) T-channel input impedance (8)

The input and output impedances are displayed at (8).

(10) Input range (13)

The input range is displayed at (13).

(11) Resolution band width (12)

The resolution band width is displayed at (12).

(12) Video band width (10)

The video band width is displayed at (10)

(13) Delay time range (9)

The delay time range is displayed at (9) only if DELAY is selected.

(14) ADV FUNCTION (14)

The lowest line (14) is used to display the ADV functions. The functions are displayed as follows:

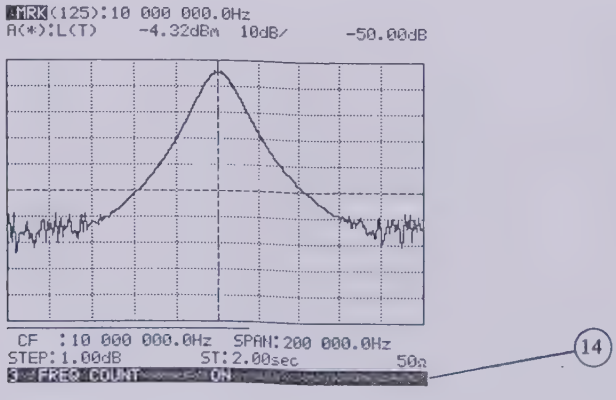


Fig. 2-16 ADV FUNCTION

2.8 OPERATION

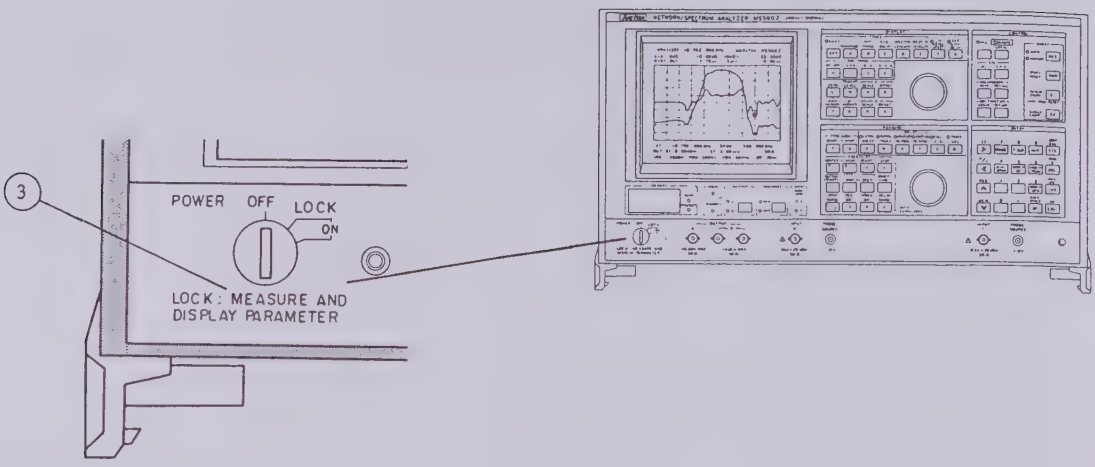


Fig. 2-17 Operation (1)

(1) POWER③

Note

The MS560J is provided with two kinds of power switch keys, X and W. When the W key is used, most of the functions shown on the front panel are disabled.

The power switch has three modes any one of which can be selected by key.

(a) OFF mode: Power off.

(b) LOCK mode: Power is on, but the keys indicated in Fig. 2-18 can not operate. When the power is on, the initial status of the front panel is as shown in Fig. 2-19.

(c) ON mode: Power is on and all front panel functions are operable.

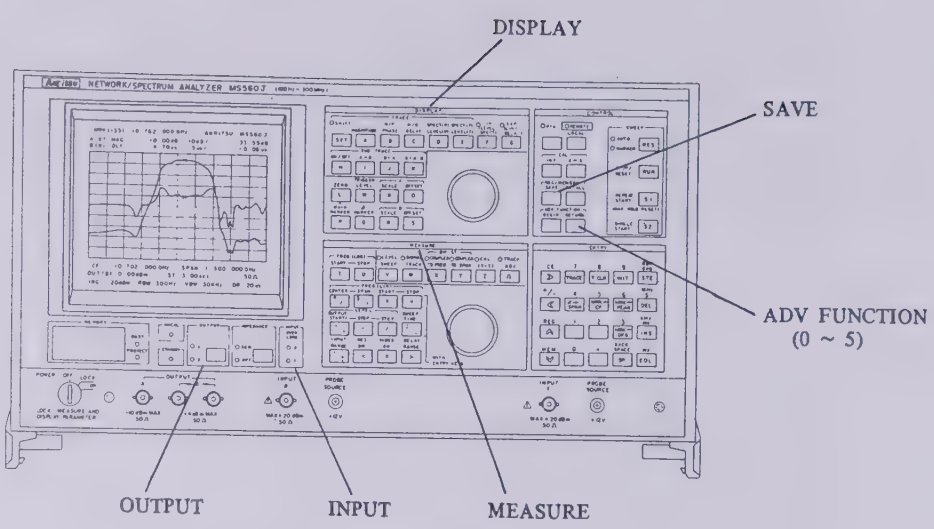
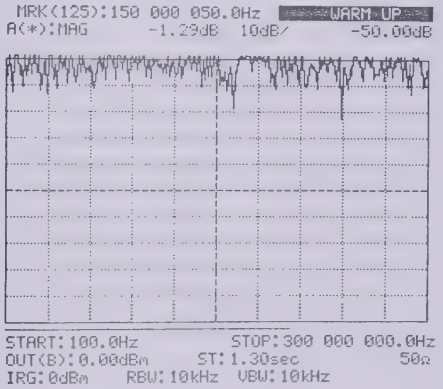


Fig. 2-18 Panel LOCK

(1) SCREEN display



(2) Function

LIN . . . . . OFF
EXP . . . . . OFF

TRACE	SCALE	OFFSET
PHASE	50 deg/	0 deg
DELAY	10 mS/	0 mS
L (R), S (R)	10 dB/	–50 dBm
L (T), S (T)	10 dB/	–50 dBm

FREQ (LOG)
- START . . . . . 100 Hz
- STOP . . . . . 300 MHz

FREQ (LIN)
- CENTER . . . . . 150000000.0 Hz
- SPAN . . . . . 300000000.0 Hz

LEVEL
- OUT (START) . . . . . 0 dBm
- STOP . . . . . 9 dBm
- STEP . . . . . 1 dB

DELAY RANGE . . . . . 40 mS
LEVEL SWEEP . . . . . OFF
SIGNAL TRACK . . . . . OFF
COUPLED TO FREQ . . . . . OFF
COUPLED TO SPAN . . . . . OFF
CAL (X-S) . . . . . OFF
TRACK ADJ . . . . . OFF

SWEEP
- AUTO/MARKER . . . . . AUTO
- REPEAT . . . . . ON

ADV FUNCTION
- INTEGRATING . . . . . OFF
- MAX HOLD . . . . . OFF
- FREQ COUNT . . . . . OFF
- TRACKING ΔF . . . . . OHz
- TRACKING MODE 0
- AUTOCAL TIME 0
- SWEEP MARKER . . . . . ON
- BUZZER . . . . . ON

Fig. 2-19 Initial Status

Note

After the power is turned on, the screen shown in Fig. 2-20 (A) appears on the screen And then about 15 minutes later, the screen shown in Fig. 2-20 (B) appears on the screen and the internal (INT) calibration is performed. Be sure to wait for this display before using the MS560J. Refer to item (32) for details of INT calibration.

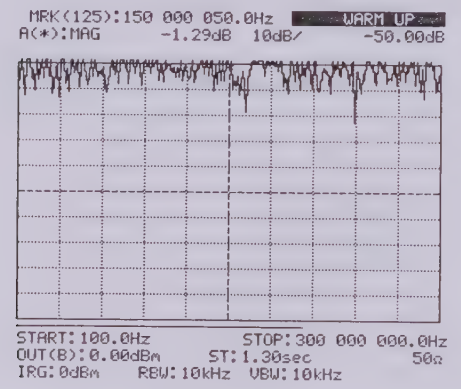


Fig. 2-20 (A) WARM-UP

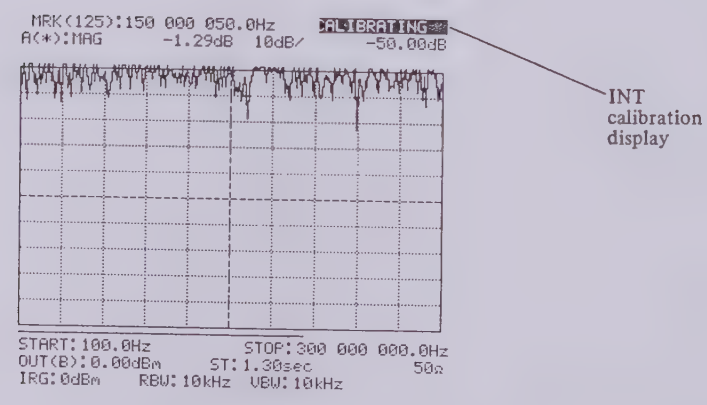


Fig. 2-20 (B) INT calibration

MEMO

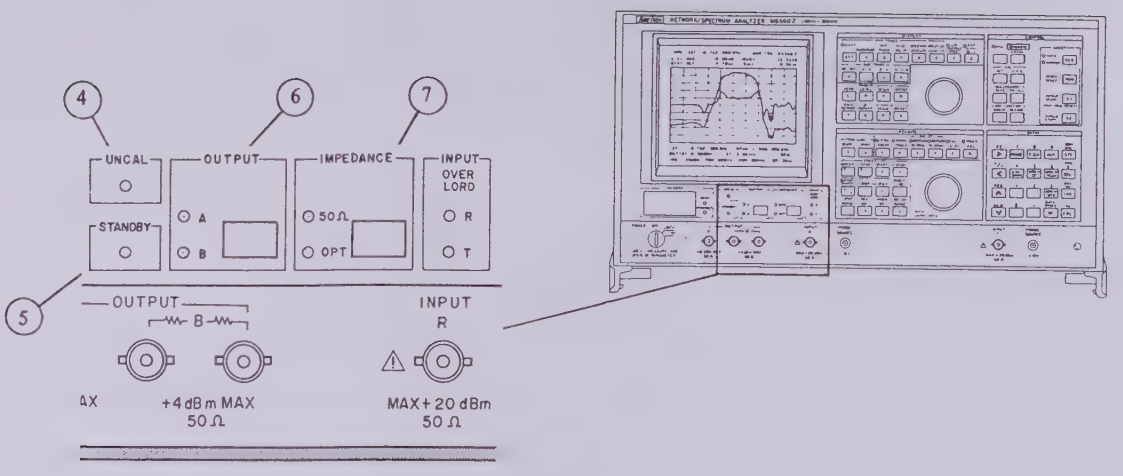


Fig. 2-21 Operation (2)

(2) UNCAL lamp (4)

If this lamp lights, it means that a measured value shown on the screen is wrong. This lamp can be turned off by increasing any one of ST, RBW and VBW. Try to set these items so that this lamp stays off. Refer to SECTION 3 for detail operation.

(3) OUTPUT (6)

Every time this key is pressed, lamps A and B light alternately as the synthesizer output terminal switches between OUTPUT - A and OUTPUT - B (18).

A: Signals are output to OUTPUT - A (18).

B: Signals are output to OUTPUT - B (18).

Note

When output-B is used, both OUTPUT-B terminals are terminated with 50 Ω, the output level of both are equal to the level displayed on the screen.

(4) INPUT-OVER LOAD (7)

This lamp lights when the input signal is higher level than IRG. Set IRG so that this lamp remains off.

when the lamp is on: Increase IRG until the lamp goes out.

when the lamp is off: Decrease IRG as far as possible without tuning the lamp on

CAUTION

If the OVERLOAD lamp does not turn off when in the +20 dBm range, disconnect the device under test immediately. Continued use at this level, even for a short time, may cause the input circuit of the MS560J to burn out.

(5) IMPEDANCE (7)

Each time this key is pressed, the input and output impedances are switched to OPT and 50 Ω.

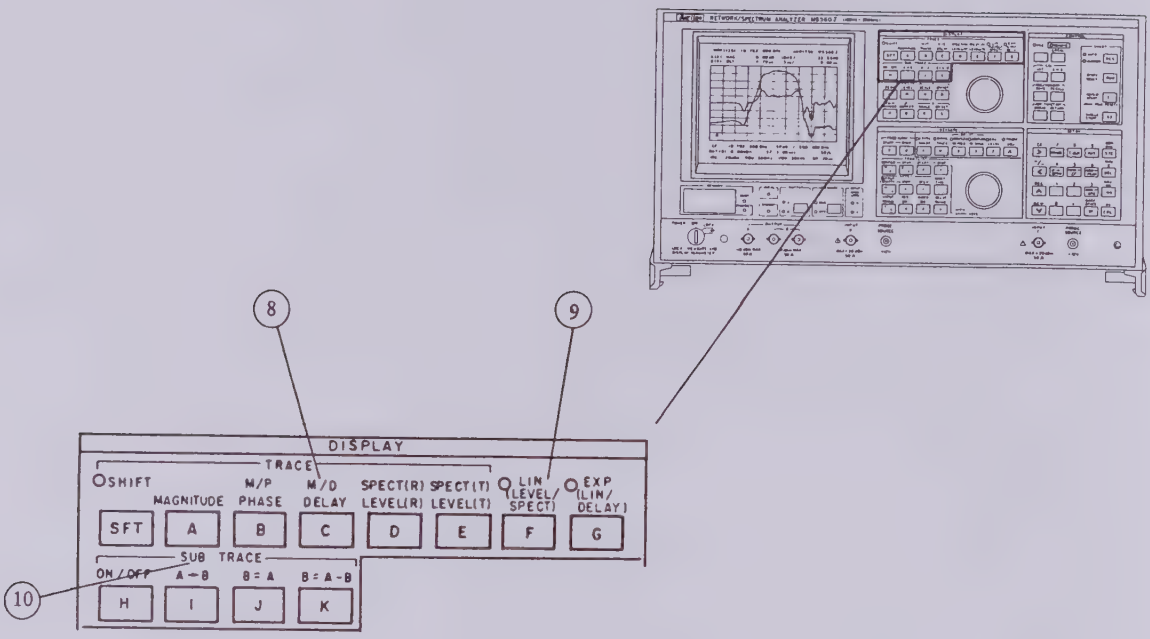


Fig. 2-22 Operation (3)

(6) TRACE⑧

Any of the following measuring items can be activated when the appropriate is pressed. Each time [SHIFT] key is pressed, the SHIFT lamp will turn on and off alternately.

Table 2-4 TRACE

Measuring items	Key operations		CRT display
	SHIFT lamp	[TRACE] key	
Magnitude	ON, OFF	[MAGNITUDE]	A(*): MAG
Magnitude/phase	ON	[M/P PHASE]	A (*): MAG B (*): PHA
Phase	OFF		A (*): PHA
Magnitude/delay time	ON	[M/D DELAY]	A (*): MAG B (*): DLY
Delay time	OFF		A (*): DLY
Spectrum (R)	ON	[SPECT (R) LEVEL (R)]	A (*): S (R)
Level (R)	OFF		A (*): L (R)
Spectrum (T)	ON	[SPECT (T) LEVEL (T)]	A (*): S (T)
Level (T)	OFF		A (*): L (T)

(7) LIN, EXP ⑨

Each time this key is pressed, the lamp turns on and off alternately and one of the measuring functions of the following table is set. This lamp cannot be turned on under any conditions other than those listed in the table. Further, if the conditions shown in the table cease to be satisfied, this lamp automatically turns off.

Table 2-5 LIN/EXP

LIN	EXP	Conditions	Measuring function
ON	OFF	When the TRACE is S (R), S (T), L (R), or L (T) and the frequency sweep width is not 0 Hz.	Indicated linearly on the vertical axis.
ON	ON		Indicated linearly and expanded 10 times around the trigger level center on the vertical axis.
ON	OFF	When the TRACE is S (R), S (T), L (R), or L (T) and the frequency sweep width is 0 Hz.	Indicates the envelope of an input signal (video sweep)
ON	ON		Indicates the envelope expanded 10 times around the trigger level center.
OFF	ON	When the TRACE setting is DELAY.	Expansion mode of delay time.

(8) SUB TRACE ⑩

This function is very effective in making single item measurements (except magnitude/phase and magnitude/delay time). Pushing each key once selects the next function.

[ON/OFF]: When this key is pressed, the SUB TRACE function can be turned on an off alternately. When SUB TRACE is turned on, the contents of the B-channel memory are displayed on the screen.

[A → B]: The latest measured-value is copied into the B-channel memory and held there and the copied memory contents are displayed on the screen. SCALE and OFFSET have the same values as the A channel.

[B = A]: A value matching that of the item selected by TRACE is displayed on the screen. SCALE and OFFSET have the same values as the A channel.

[B = A – B]: The difference between the newly measured value and B-channel memory contents copied at A → B is displayed. SCALE and OFFSET have the same value as the A channel.

Note

The display of SUB TRACE on the screen can be adjusted by SCALE and OFFSET of the B channel.

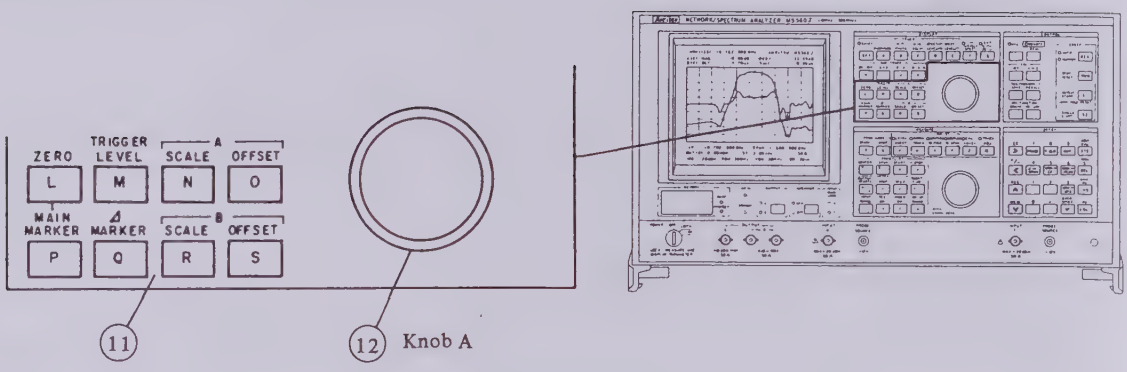


Fig. 2-23 Operation (4)

(9) ZERO (11)

When this key is pressed, the latest value measured at the marker point is memorized and the difference between it and the current value measured at the marker point is displayed on the screen. This function is released by pressing the [MAIN MARKER] key.

(10) MAIN MARKER (11)

After this key is pressed once, the knob A (12) can be used to move the main marker, and the frequency and value measured at the marker point are displayed on the screen.

(11) ΔMARKER (11)

When this key is pressed, the current main marker is copied on the screen. If the main marker is then moved, two markers are displayed on the screen, and the difference between them is displayed together with the frequency and measured values. To release this function, press the [MAIN MARKER] key.

(12) TRIGGER LEVEL (11)

If this key is pressed while running a linear display or video sweep, the trigger level can be adjusted by knob A (12). Refer to paragraph 3.2.5 for details of video sweep operation.

(13) A-SCALE, OFFSET (11)

When the [SCALE] key is pressed, the scale of the vertical axis on the screen can be adjusted by knob A (12). Pushing of [OFFSET] key enables knob A (12) to move the waveform on the screen by 1/10 of the current screen scale.

Note

1. *Turn knob A (12) clockwise or counterclockwise to move the waveform upward or downward.*
2. *When the waveform is off screen, increase SCALE.*
3. *When the top or bottom of the scale is displayed brightly, the waveform is off scale on the screen.*
4. *During linear display or video sweep operations, SCALE is disabled and OFFSET is used to adjust the range.*

(14) B-SCALE, OFFSET (11)

This key is functionally the same as (13) above and is used in the following cases:

Magnitude/phase:	Adjustment of the phase waveform
Magnitude/delay time:	Adjustment of the delay time waveform
SUB TRACE:	Adjustment of the B-channel waveform

Note

This key is disabled during linear display and video sweep operations.

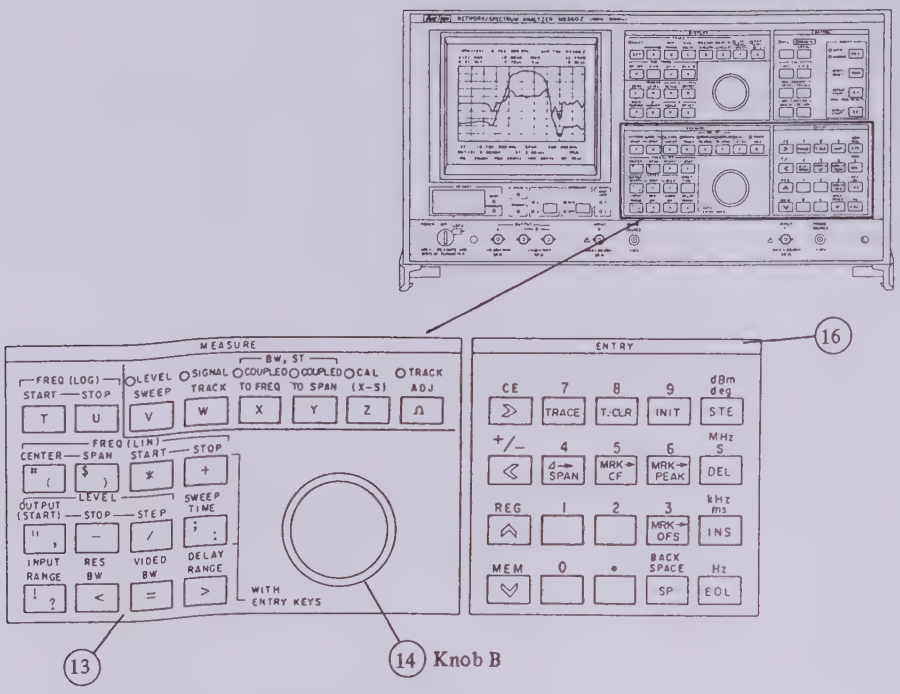


Fig. 2-24 Operation (5)

(15) FREQ (LOG) (13)

If the START or STOP key is pressed, the logarithmic frequency sweep mode is selected and the start or stop frequency of the logarithmic sweep can be selected from among the following values by knob B (14).

Start frequency (START): 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz, and 10 MHz

Stop frequency (STOP): 1 kHz, 10 kHz, 100 kHz, 1 MHz, 10 MHz, 100 MHz and 300 MHz

Note

Logarithmic sweep operation start and stop frequencies other than the above can be set using the PTA1 option or a personal computer through GP-IB.

(16) FREQ (LIN) CENTER/SPAN (13)

When the [CENTER] or [SPAN] key is pressed, the frequency linear sweep mode is selected and the sweep center frequency or sweep band width can be set with knob B (14) or the ENTRY keys (16).

Center frequency (CF): 100.0 to 300000000.0 Hz

Band width (SPAN): 0 to 300000000.0 Hz

The resolution here is 25 Hz.

Setting frequency

Method	Step	Operation
a	1	Press the [CENTER] or [SPAN] key.
	2	Turn knob B (14) to set the desired frequency.
b*		Press these keys in order: [CENTER] [1] [2] [.] [4] [MHz].
c*		Press these keys in order: [SPAN] [5] [0] [kHz].
d*		Press these keys in order: [1] [0] [0] [kHz]. (See Note)

* Example: (b) Center frequency = 12.4 MHz
(c) Span = 50 kHz
(d) Reset span to 100 kHz

Note

(1) When changing condition of items that is shown on an inverse video line as in Fig. 2-25, only set data may be set by using method d.

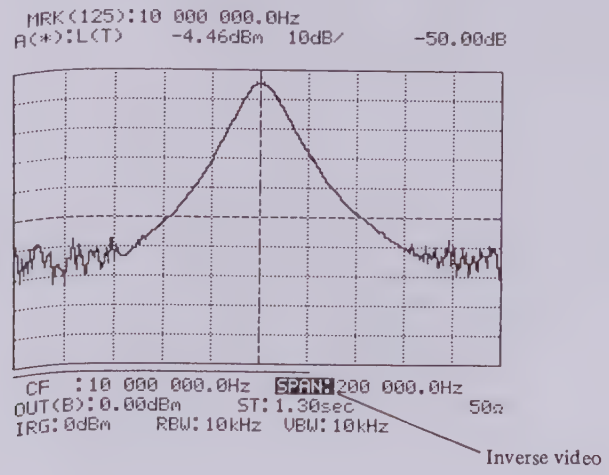


Fig. 2-25 Inverse Video Display

(2) ENTRY key (16)
The ENTRY key is used in combination with some of the MEASURE keys and the [SAVE] and [RECALL] keys.

- *[CE]: Used to clear all keyed-in values before the unit key (dBm/deg, MHz/S, kHz/mS, and Hz) is pressed.*
- *[+/–]: Used to invert the sign of the input data.*
- *[REG]/[MEM]: Used in combination with the [SAVE] and [RECALL] keys.*
- *[0] - [9], [.] : Data input keys.*
- *[BACK SPACE]: Used to clear the least significant digit of input data.*
- *[dBm/deg], [MHz/S], [kHz/mS], and [Hz]: Unit keys, when pressed, activate keyed input.*

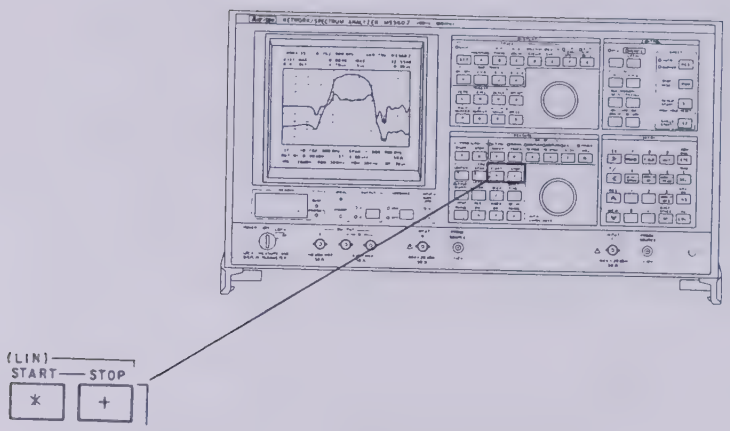


Fig. 2-26 Operation (6)

(17) FREQ (LIN) START/STOP (13)

When the [START] or [STOP] key is pressed, the frequency linear sweep mode is selected and the start or stop frequency of sweep can be set by knob B (14) or the ENTRY keys (16).

Start or stop frequency: 0 to 300000000.0 Hz

The resolution is 25 Hz and the stop frequency most be greater than the start frequency.

Setting frequencies:

Method	Step	Operation
a	1	Press the [START] or [STOP] key
	2	Turn knob B (14) to set the desired frequency.
b*		Press these keys in order: [START] [1] [0] [.] [7] [MHz].
c*		Press these keys in order: [STOP] [2] [1] [.] [5] [MHz].
d*		Press these keys in order: [2] [5] [MHz]. (See Note)

* Example: (b) Start = 10.7 MHz
(c) Stop = 21.5 MHz
(d) Reset stop to 25 MHz

Note

1. *Items which are already shown on an inverse video line may be set only by using the ENTRY keys (method d).*
2. *Frequency of LOG (START/STOP), LIN (START/STOP) and LIN (CENTER/SPAN) which is already set can be recalled only by pressing the rated MEASURE key.*
3. *See item (16) for ENTRY key operation.*

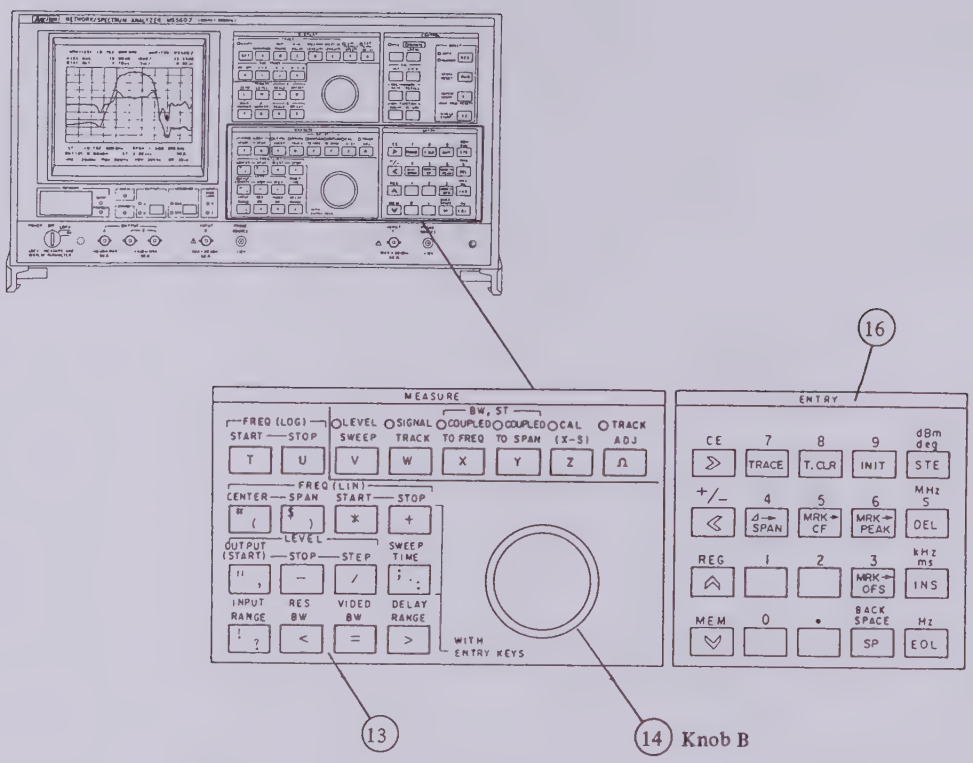


Fig. 2-27 Operation (7)

(18) LEVEL (13)

These keys are used to set the sysnthesizer output level.

OUTPUT A: −110 to +10 dBm, resolution 0.01 dB.

OUTPUT B: −110 to +4 dBm, resolution 0.01 dB.

(a) [OUTPUT (START)]: When this key is pressed, the synthesizer output level can be set with knob B (14) or the ENTRY keys (16). When setting with knob B, the level can be increased or decreased by STEP value set in item (C) below. For level sweep operations, this key is used to set the start level.

(b) [STOP]: When this key is pressed, the stop level for level sweep operations can be set by knob B (14), or the ENTRY keys (16). When setting with knob B (14), the level can be increased or decreased by STEP value set in item (C) below.

(c) [STEP]: When this key is pressed, the STEP level for level sweep operations can be set by knob B (14) or the ENTRY keys (16). When setting with knob B (14), the level is changed by half (decrement) or twice (increment) just before starting operation.

Setting the level

Method	Step	Operation
a	1	Press the [OUTPUT], [STOP] or [STEP] key.
	2	Turn knob B ⑭ to set the desired level.
b		Press these keys in order: [STOP] [+/–] [5] [0] [.] [0] [5] [dBm] .
c		Press these keys in order: [1] [0] [.] [1] [7] [dBm] . (See Note)

Note

1. *Items which are already shown in an inverse video line on the screen may only be set by the ENTRY keys (method c).*
2. *See item (16) for ENTRY key operation.*

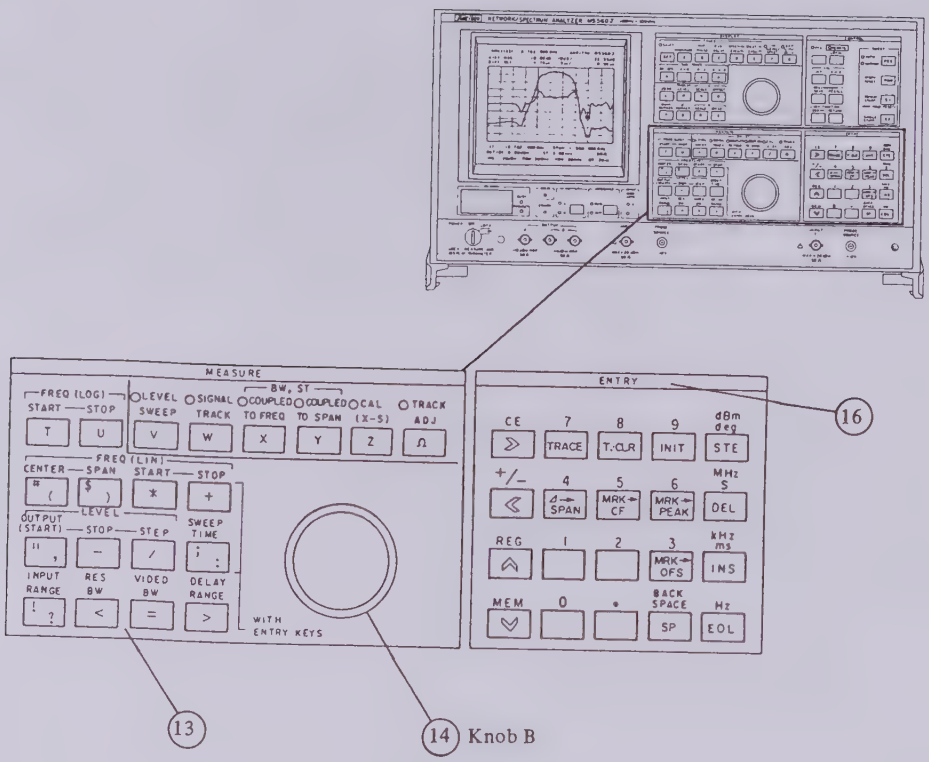


Fig. 2-28 Operation (8)

(19) SWEEP TIME (ST) (13)

After pressing this key, the sweep time can be set by knob B (14) or the ENTRY keys (16).

Setting range

- Knob B (14): 100 ms to 25 hours

  The minimum value varies according to the item being measured.

- ENTRY key (16): 100 ms to 9000 s.

  When the EOL key is pressed, the unit can be translated automatically to ms, s, min, and hour with two significant figures.

Setting Sweep time

Method	Step	Operation
a	1	Press the [SWEEP TIME] key.
	2	Turn knob B (14) to set the desired value.
b		Press these keys in order: [SWEEP TIME] [5] [0] [0] [mS].
c		Press these keys in order: [1] [0] [0] [0] [mS]. (See Note 1)

Note

1. *Items already shown in an inverse video line on the screen can only be set by the ENTRY keys.*
2. *See item (16) for ENTRY key operation.*

(20) INPUT range (13)

After pressing this key, knob B (14) can be used to set the input range. The R and T channels are always set to the same range.

(21) RES BW (RBW) (13)

After pressing this key, knob B (14) can be used to set the resolution bandwidth.

(22) VIDEO BW (VBW)

After pressing this key, knob B (14) can be used to set the video bandwidth.

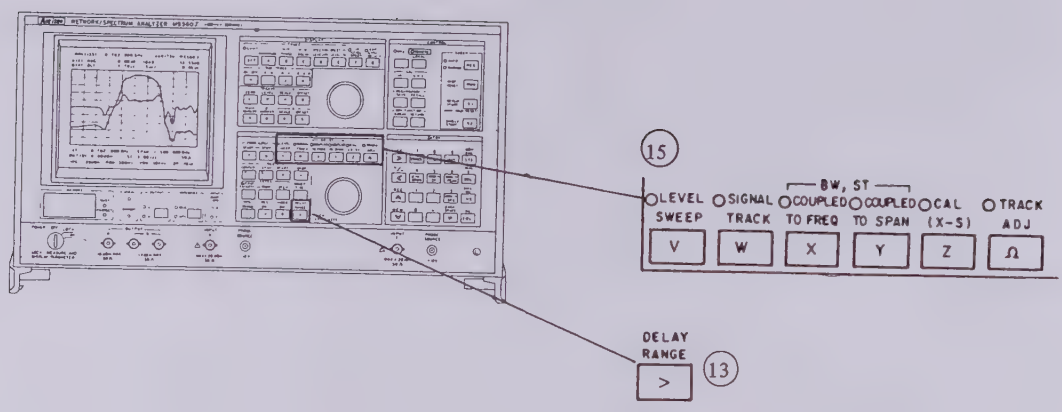


Fig. 2-29 Operation (9)

(23) DELAY RANGE (DR) (13)

After pressing this key, knob B (14) can be used to set the delay time range. This can be set only if the delay time has been set as a TRACE (measurement item).

CAUTION

MISSETTING DR SOMETIMES LEADS TO GROSS ERRORS. BE SURE TO USE THE CORRECT OPERATION METHOD TO MEASURE THE DELAY TIME ACCORDING TO PARAGRAPH 3.1.4.

(24) LEVEL SWEEP (15)

Each time this key is pressed, the lamp turns on or off alternately. When this lamp is on, the synthesizer output level is swept. See paragraph 3.3 for further details.

(25) SIGNAL TRACK (15)

For LEVEL and SPECTRUM measurements, the lamp is turned on or off alternately each time this key is pressed.

If this lamp is on and the frequency sweep is linear mode, the frequency is reset for each sweep so that the peak value of the input signal is made the center of the sweep.

(26) COUPLED TO FREQ (15)

Each time this key is pressed in MAGNITUDE, PHASE, DELAY or LEVEL measurement, this lamp turns on or off alternately. When this lamp is on, the RBW, VBW and ST are automatically set in relation to the measuring frequency. See paragraph 3.5-(2) for further details.

(27) COUPLED TO SPAN (15)

For SPECTRUM measurements, the lamp turns on or off alternately each time this key is pressed. When this lamp is on, the RBW, VBW and ST are automatically set in relation to the sweep width. See paragraph 3.5-(3) for further details.

(28) CAL (X – S) (15)

Each time this key is pressed, the lamp turns on or off alternately. When this lamp is on, the measured values are automatically corrected by the contents of S memory stored during the X→S calibration.

Note

Be sure to press the $\boxed{X \rightarrow S}$ *key before turning on the X – S lamp, otherwise the measured values are corrected by the incorrect data. See paragraph 2.10-(3) for further details.*

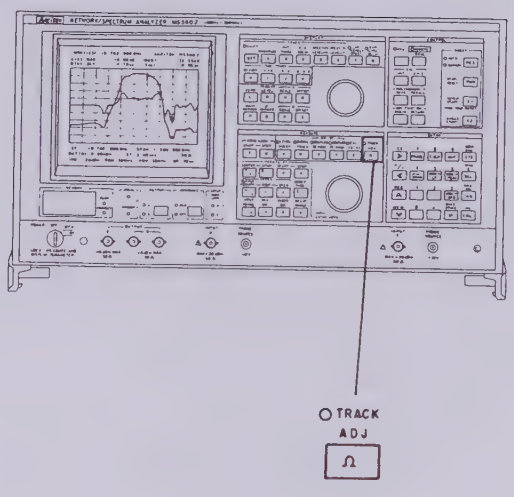


Fig. 2-30 TRACK ADJ

(29) TRACK ADJ (15)

When RBW is less than 300 Hz, the lamp turns on or off each time this key is pressed. When this lamp is on, the center frequency of the intermediate frequency filter can be adjusted as described below. This adjustment is required to obtain the best dynamic range for transmission characteristics and the best accuracy for level measurements.

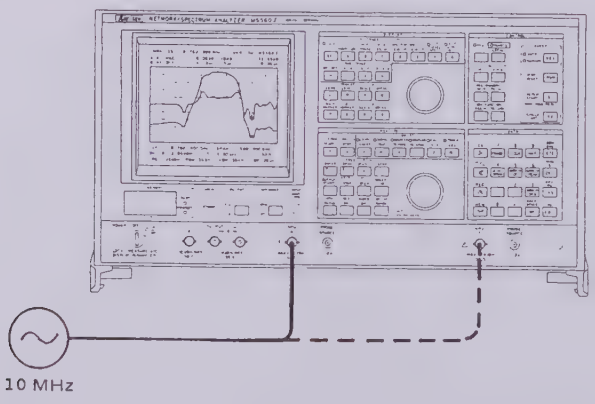


Fig. 2-31 Connection for TRACK ADJ

Adjustment:

Step	Procedure
1	Connect the input terminal to the signal whose frequency (Fo) is previously known. *Note* *The STD OSC output on the rear panel can be used for the signal above.*
2	Set the MS560J as follows: • CF . . . . . Fo • SPAN . . . . . 1 kHz • TRACE . . . . . L (R) or L (T) • TRACK ADJ . . . . . ON • RBW . . . . . One of 3 Hz to 300 Hz
3	Adjust the IRG so that the OVLD lamp does not light.
4	Adjust the ST so that the UNCAL lamp does not light.
5	Adjust the knob-B so that the top of the spectrum appears at the center of the screen.
6	Turn off the TRACK ADJ lamp.

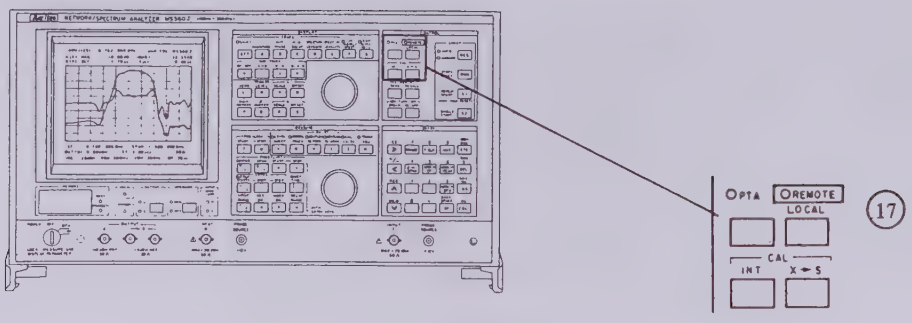


Fig. 2-32 Operation (10)

(30) PTA (17)

When the PTA1 option is incorporated in the MS560J, the lamp turns on or off each time this key is pressed. Refer to the PTA1 OPERATION MANUAL for further details.

(31) LOCAL (17)

When the MS560J is controlled through GP-IB and if this key is pressed when the REMOTE lamp is on, the REMOTE lamp will turn off. Local control of the MS560J is activated.

(32) CAL-INT (17)

After this key is pressed, INT calibration mode is established once the sweep operation ends.

Note

1. *Nonlinear errors are collected during INT calibration and calibrated automatically during the measurement cycle.*
2. *Calibration connections are made automatically inside the MS560J during INT calibration.*
3. *Calibration starts in one of the following three situations:*
   - *15 minutes after the power is turned on.*
   - *When the [CAL-INT] key is pressed.*
   - *Once the period set on the timer has elapsed. Refer to item (35) for details on setting the timer.*
4. *About 15 minutes after the power is turned on, the INT calibration is performed automatically. If this function is not necessary, perform the following operation.*
   - *Press [BEGIN] key*
   - *Press [/] [7] [EOL] keys in this order*
   - *Press [0] [EOL] keys in this order*
   - *Press [RETURN] key*
   - *Press [CAL-INT] key*

MEMO

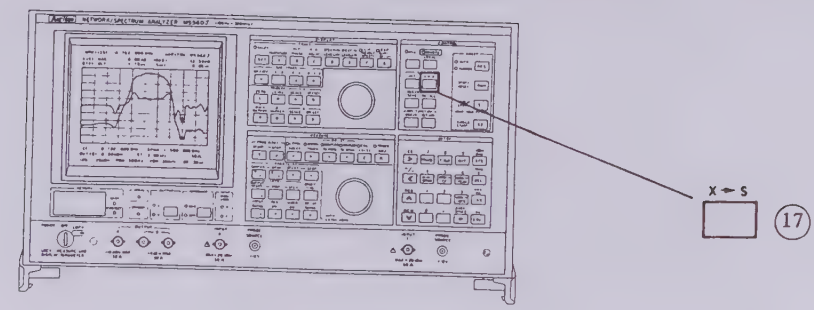


Fig. 2-33 Operation (11)

(33) CAL – X→S (17)

After this key is pressed, one sweep establishes the X→S calibration mode and all measured values are stored into S memory.

Note

1. *X→S calibration is used to correct offset errors, including frequency response of the measuring system.*
2. *X→S calibration only stores the measured values in S memory. The CAL – X–S lamp (15) must be on to correct offset errors.*
3. *X→S calibration of transmission characteristics usually uses a direct connection circuit as reference.*
4. *For level measurements, the synthesizer output level is used as a reference level. The following levels are used for calibration.*
   - *+20 dBm IRG . . . . . 0 dBm*
   - *+10 dBm IRG . . . . . 0 dBm*
   - *0 dBm IRG . . . . . 0 dBm*
   - *–10 dBm IRG . . . . . –10 dBm*
   - *–20 dBm IRG . . . . . –20 dBm*
   - *–30 dBm IRG . . . . . –30 dBm*
   - *–40 dBm IRG . . . . . –40 dBm*
5. *Connection for X→S calibration is shown in Figs. 2-34 and 2-35.*

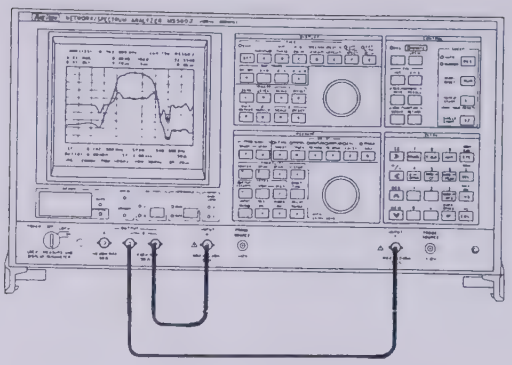


Fig. 2-34 Transmission Characteristic

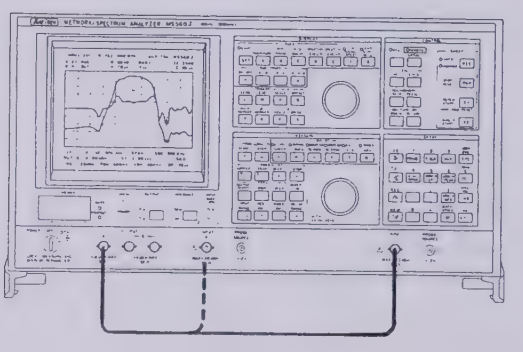


Fig. 2-35 Level/Spectrum

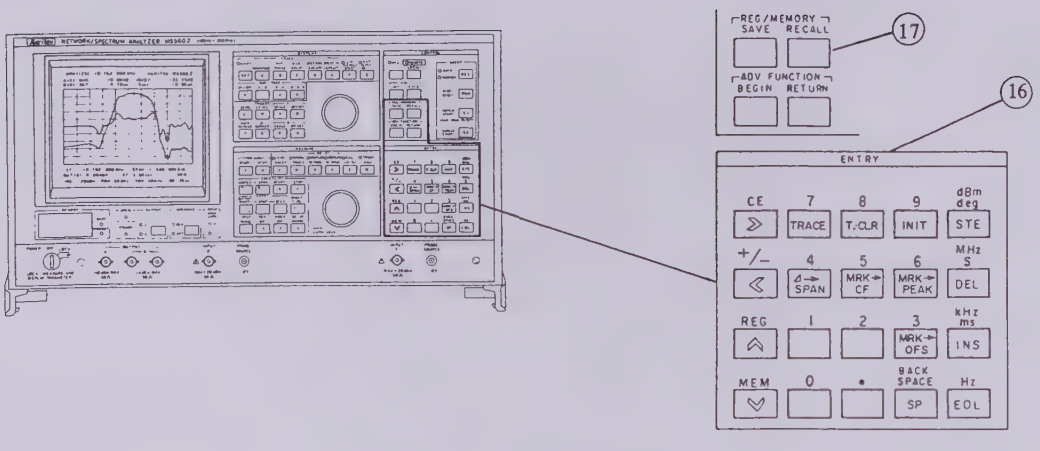


Fig. 2-36(A) Operation (12)

(34) REG/MEMORY (17)

The [SAVE] and [RECALL] keys are used to store and recall the front panel setting status.

- REG mode: Can store three panel setting states. Stored data will be void as the power is off.
- MEMORY mode: Refer to item (40).

Operating method (REG mode)

Method	Opeation
a.	Press these keys in order: [SAVE] [REG]** [1]*
b.	Press these keys in order: [SAVE] [0]*
c.	Press these keys in order: [RECALL] [REG]** [2]*
d.	Press these keys in order: [RECALL] [1]*

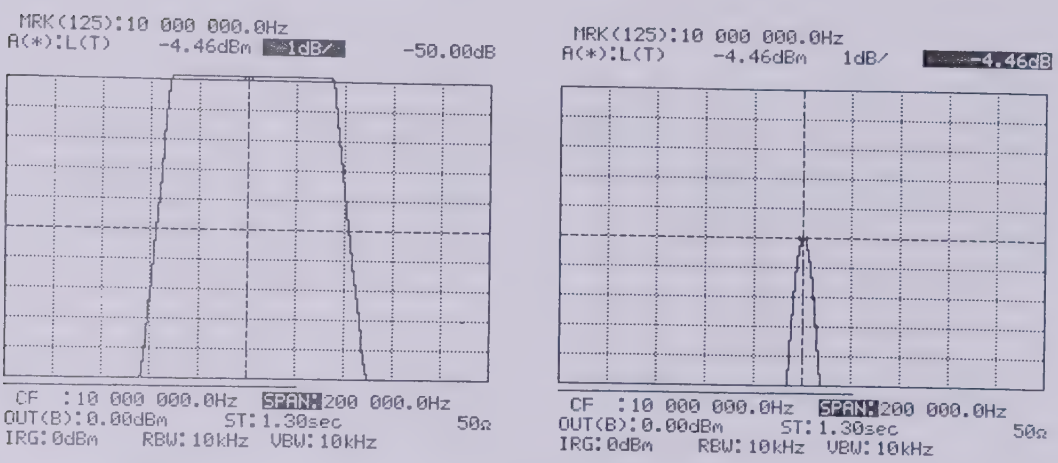
Note

1. ** must be 0, 1 or 2.*
2. *** may be omitted (method c, d).*
3. *After the power is on, the MS560J is initialized (power on status) by pressing the [RECALL] and [9] keys in this order.*

Moreover, the [SAVE] and [RECALL] keys are used to perform the following functions.

- Press the [RECALL] and [3] keys (Automatic offset setting)

  This automatically sets the offset to the marker readout value on the screen, as shown in the following figure.

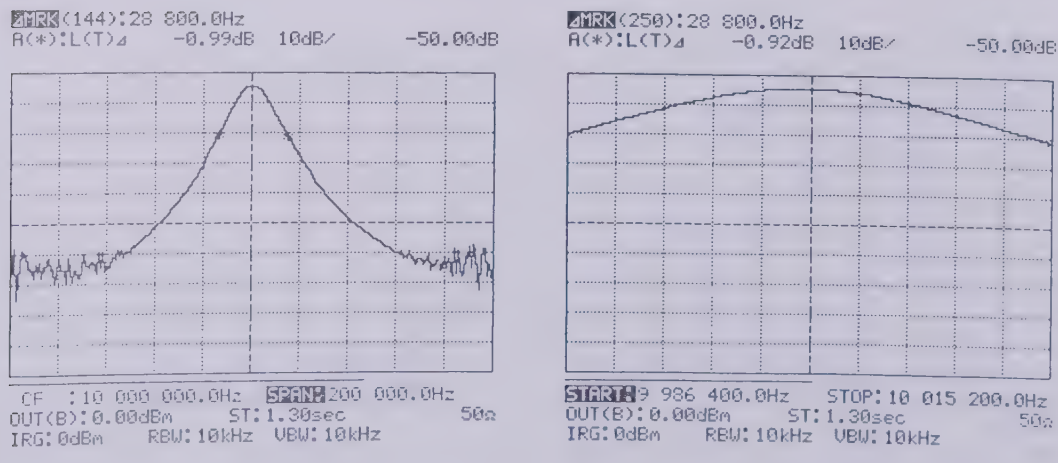


(A) Before Pressing [RECALL] and [3] Keys (B) After Pressing [RECALL] and [3] Keys

Fig. 2-36 (B) Automatic Offset Setting

- Press the [RECALL] and [4] keys (ΔF → START/STOP)

  As shown in the following figure, this automatically sets the frequency sweep mode to START/STOP. The sweep width is automatically set to the frequencies pointed by the two markers before this is done.



(A) Before Pressing [RECALL] and [4] Keys (B) After Pressing [RECALL] and [4] Keys

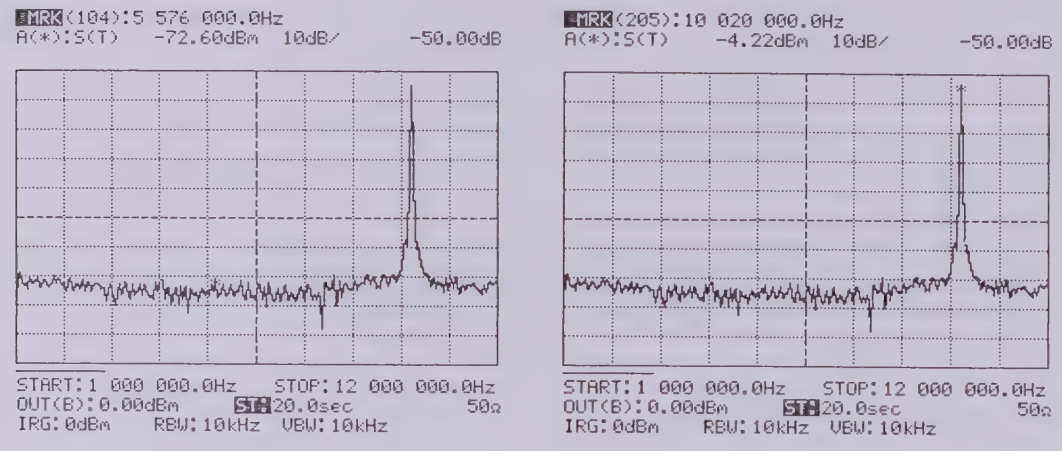
Fig. 2-36 (C) ΔF → SPAN

- Press the [RECALL] and [5] keys (Marker frequency → CF)

  This automatically sets the frequency sweep mode to CF/SPAN. The center frequency (CF) is automatically set to the main marker frequency before this is done. The main marker is automatically set to the center position on the screen.

- Press the [RECALL] and [6] keys (Marker → Peak)

  This automatically sets the main marker on the screen to the maximum point of trace-A.



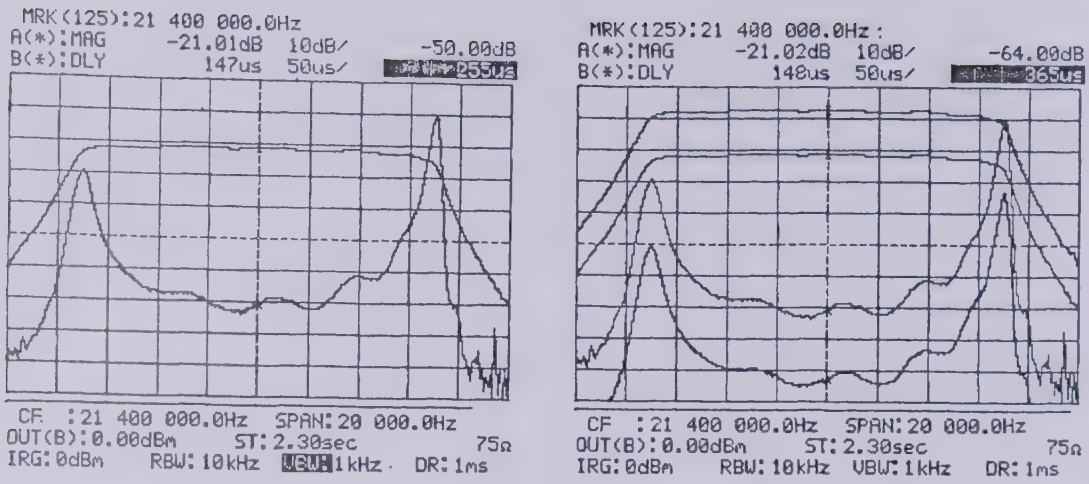
(A) Before Pressing [RECALL] and [6] Keys (B) After Pressing [RECALL] and [6] Keys

Fig. 2-36 (D) Marker → Peak

- Press the [SAVE], [MEM] and [7] keys (Save Trace)

  This stores the trace datas on the screen and the front panel setting into the plug-in-bubble-memory (PBM).

  The PBM uses to store trace datas and up to five front panel settings, or six front panel settings. Consequently, trace datas cannot be stored into the PBM that have previously stored six front panel settings.



(A) SAVE TRACE (B) RECALL TRACE

Fig. 2-36 (E) SAVE TRACE

- Press the [RECALL], [MEM] and [7] keys (RECALL TRACE)

  This displays trace datas saved in the PBM on the screen low-intensity screen. It also resets front panel settings saved in the PBM.

- Press the [RECALL], [MEM] and [8] keys (TRACE CLEAR)

  This erases trace datas displayed on the screen low-intensity screen.

- Press the [RECALL] and [9] keys (Initialization)

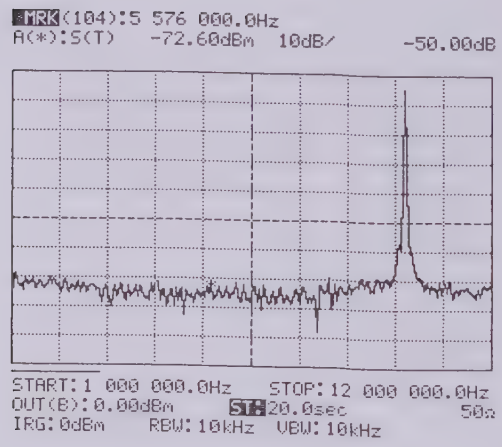
  This initializes the MS560J to the conditions originally held when the power was turned on.

- Press the [RECALL] and [5] keys (Marker frequency → CF)

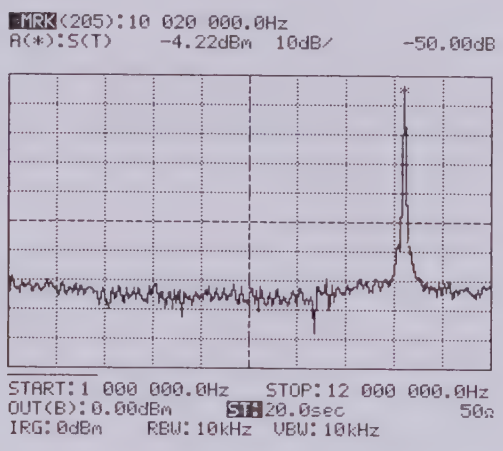
  This automatically sets the frequency sweep mode to CF/SPAN. The center frequency (CF) is automatically set to the main marker frequency before this is done. The main marker is automatically set to the center position on the screen.

- Press the [RECALL] and [6] keys (Marker → Peak)

  This automatically sets the main marker on the screen to the maximum point of trace-A.



(A) Before Pressing [RECALL] and [6] Keys



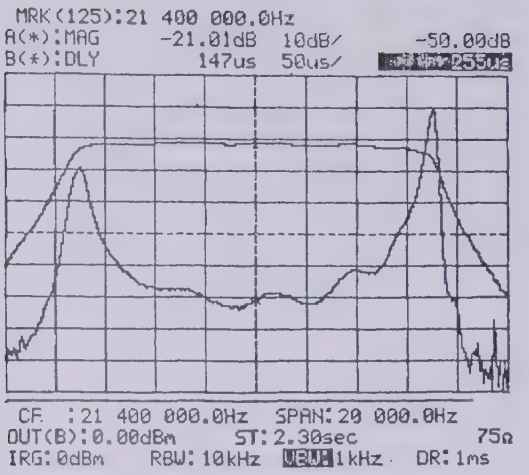
(B) After Pressing [RECALL] and [6] Keys

Fig. 2-36 (D) Marker → Peak

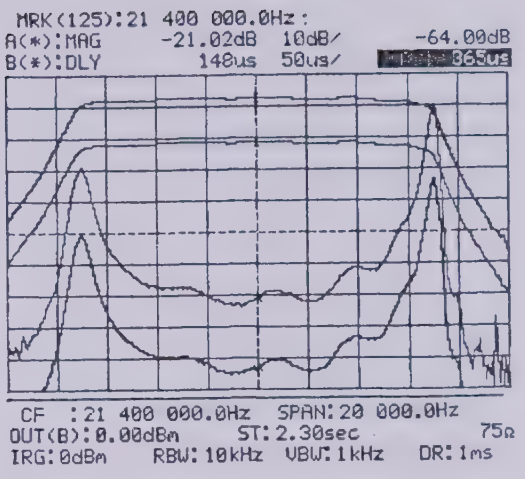
- Press the [SAVE], [MEM] and [7] keys (Save Trace)

  This stores the trace datas on the screen and the front panel setting into the plug-in-bubble-memory (PBM).

  The PBM uses to store trace datas and up to five front panel settings, or six front panel settings. Consequently, trace datas cannot be stored into the PBM that have previously stored six front panel settings.



(A) SAVE TRACE



(B) RECALL TRACE

Fig. 2-36 (E) SAVE TRACE

- Press the [RECALL], [MEM] and [7] keys (RECALL TRACE)

  This displays trace datas saved in the PBM on the screen low-intensity screen. It also resets front panel settings saved in the PBM.

- Press the [RECALL], [MEM] and [8] keys (TRACE CLEAR)

  This erases trace datas displayed on the screen low-intensity screen.

- Press the [RECALL] and [9] keys (Initialization)

  This initializes the MS560J to the conditions originally held when the power was turned on.

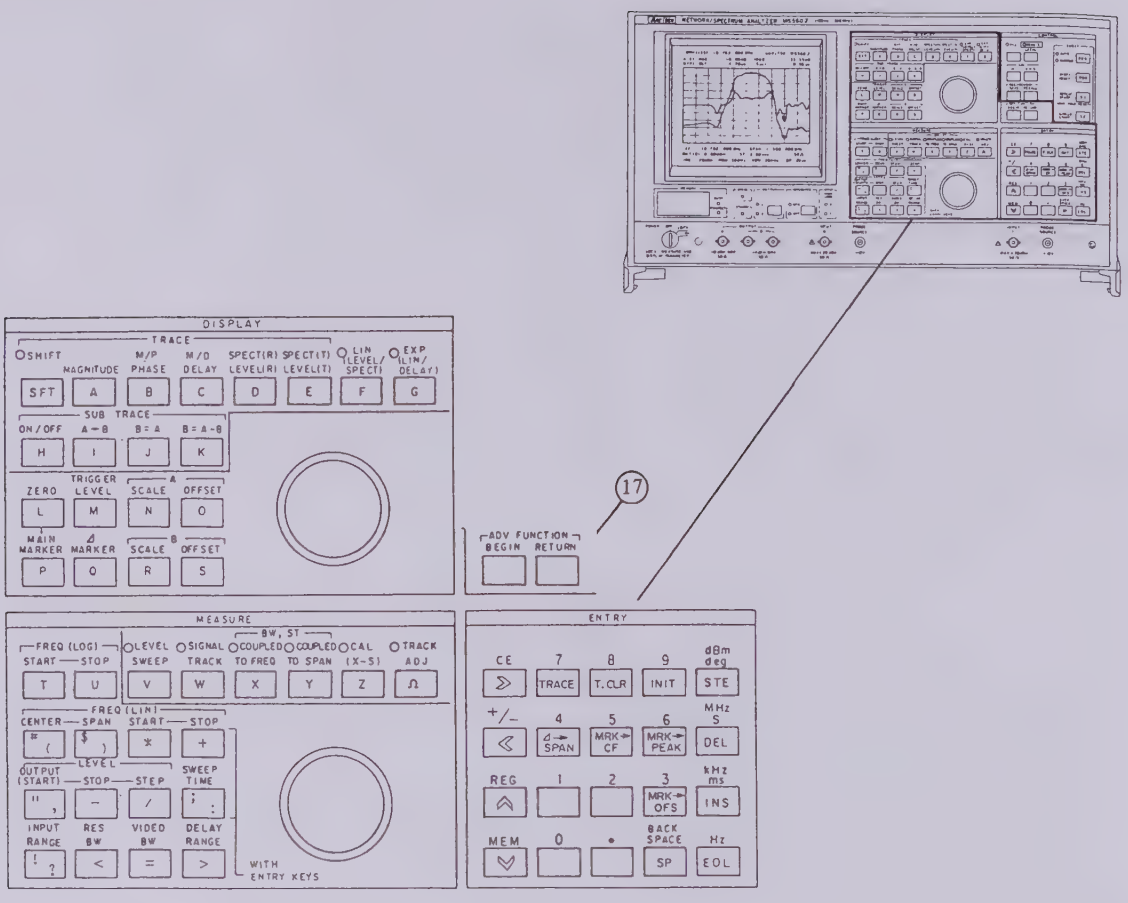


Fig. 2-37 Operation (13)

(35) ADV FUNCTION (17)

These keys are used to set several advensed functions which cannot be selected directly from the front panel. These functions are operated with the ENTRY keys and the following blue key.

Note

The following characters and keys are used with the ADV FUNCTION.

[A] ~ [Z], [a] ~ [z], [Ω], [(], [)], [*], [+], [,], [–], [/], [:], [?], [<], [=], [>], [#], [$], [”], [;], [!], [0] ~ [9], [.], [SP], [EOL]

The 16 items in the following table are available with the ADV function.

Table 2-6 ADV FUNCTION

Item		Data	Description
Number	Characters		
0	INTEGRATING	ON/OFF	Integrates the measured values
1	MAX HOLD	ON/OFF	Holds the maximum value
3	FREQ COUNT	ON/OFF	Frequency measurement
4	TRACKING Δ F	Frequency	Offset tracking
5	TRACKING MODE	0/1/2	
6	TITLE	Alphanumeric characters	Comment display
7	AUTO CAL TIME	0 ~ 99	Auto-calibration period
8	SWEEP MARKER	ON/OFF	Sweep marker on or off
9	BUZZER	ON/OFF	Buzzer on or off
10	CP-IB COMMAND	Alphanumeric characters	Control of GP-IB
11	WRITE	Alhpanumeric characters	
12	DATA OUT	Alphanumeric characters	
13	READ	Alhpanumeric characters	
14	FORMAT WRITE	GO	PBM control
15	BACK UP	ON/OFF	

Note

Items 14 and 15 are displayed only when the PBMI option is incorporated in MS560J.

(a) Explanation of functions

- INTEGRATING
  This function is used to measure a signal of poor stability. See paragraph 3.6.1 for further details.

- MAX HOLD:
  This is valid only for L (R), L (T), S (R) and S (T) and holds the maximum value of each sweep. Pressing the [REPEAT START] key clears the held data.
  See paragraph 3.6.2 for further details.

- FREQ COUNT
  This is valid only for L (R), L (T), S (R) and S (T) and measures the input signal frequency specified by the marker. Refer to paragraph 3.6.3 for further details.

- TRACKING Δ F and TRACKING MODE
  This is used to set the offset tracking parameters. Refer to paragraph 3.6.4 for further details.

- TITLE
  This enables the user to insert a comment of up to 15 characters on the upper right corner of the screen.

- AUTO CAL TIME
  This is used to set the INT calibration period in one-minute steps at from 1 to 99 minutes. For 0, INT calibration is not started from the timer.

- SWEEP MARKER

- BUZZER

- GP-IB COMMAND, WRITE, DATA OUT and READ
  These functions are fully explained elsewhere in this manual according to how they are used with various other functions.
  See paragraph 3.6.4, 3.6.5 and GP-IB Operation Manual.

- FORMAT WRITE and BACK UP
  Refer to item (40) for details.

(b) Operating method

Operation of the ADV Function starts when the [BEGIN] key is pressed and ends when the [RETURN] key is pressed. When the [BEGIN] key is pressed, the bottom line on the screen is displayed with inverse video as shown in Fig. 2-38. This indicates that the ADV FUNCTION has been called and is ready.

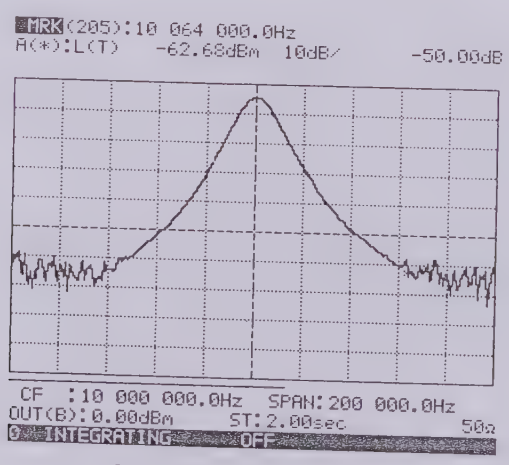


Fig. 2-38 ADV FUNCTION

Step	Procedure
1.	Press [BEGIN] key.
2.	Press [/] [6] [EOL] keys in this order.
3.	Press [M] [S] [5] [6] [0] [J] keys in this order.

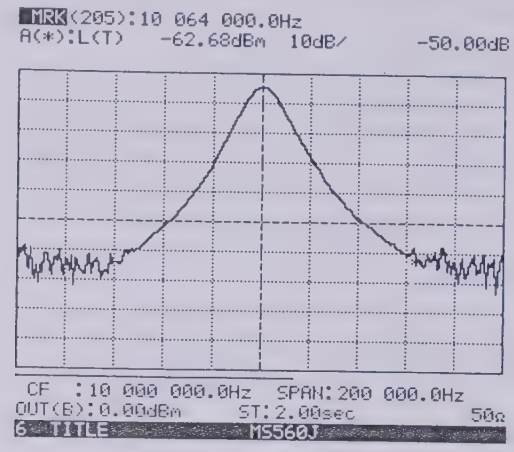


Fig. 2-39 TITLE (1)

4. Press [EOL] key.

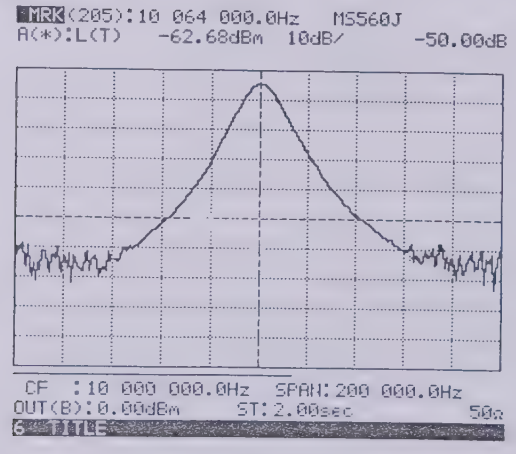


Fig. 2-40 TITLE (2)

5. Press [RETURN] key.

Note

1. *Every function can be called in order by pressing the [▽] or [△] key.*
2. *The above procedure is for the TITLE function. The procedure for the other functions is similar to the above.*

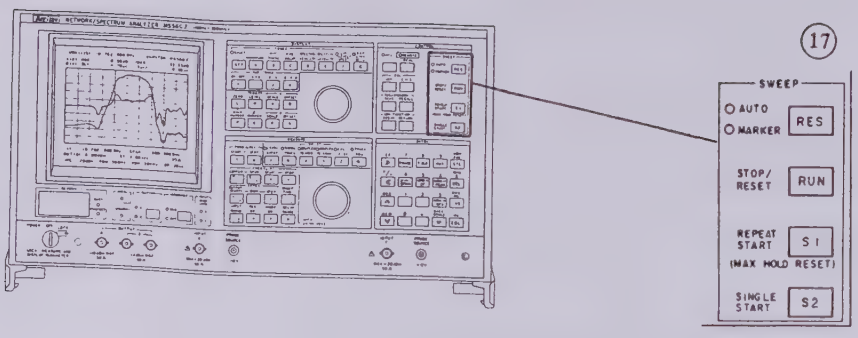


Fig. 2-41 Operation (14)

(36) AUTO/MARKER (17)

Each time this key is pressed, the AUTO and MARKER lamps turn on alternately.

AUTO: Sweeps the entire range.

MARKER:

ΔMARKER Off: Measures only at the main marker point.

ΔMARKER on: Sweeps between two markers.

(37) STOP RESET (17)

When this key is pressed, the following operations are carried out.

During a sweep operation: Stops the sweep.

During suspension of a sweep operation: Returns to the sweep starting point and stops the sweep.

(38) REPEAT START (17)

When this key is pressed, the following operations are carried out.

During sweep operation or when operation is suspended at the sweep start point: Initiates the sweep repeatedly from the start point.

During suspension of a sweep operation: Continues the sweep and repeats it.

Note

When MAX HOLD is ON, the data is initialized by pressing this key.

(39) SINGLE START (17)

When this key is pressed, the following operations are carried out.

During a sweep operation: Sweeps from the start point only once.

During suspension of a sweep operation: Continues the sweep and sweeps only once.

(40) MEMORY (2)

When the PBM is plugged into the built-in PBMI (Plug-in Bubble Memory Interface) socket, the memory mode SAVE/RECALL and BACK UP functions can operate. The PBM can also be used as a program file for the PTA1 option. For using the PTA1 option, please refer to the PTA1 OPERATION MANUAL for details.

(a) Write Protect

As the Fig. 2-42 shows, the PBM is provided with a slide key for write protection. If this key is set to Write Inhibit, data cannot be written. When the PBM is inserted into the socket, the PROTECT lamp (green) lights.

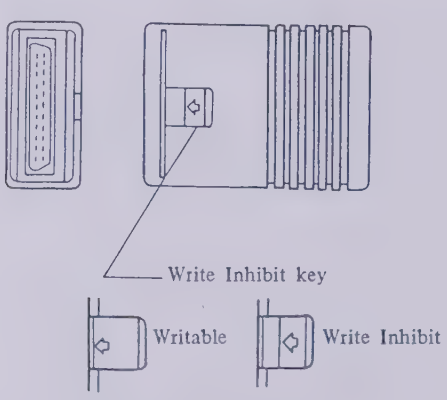


Fig. 2-42 Write Protect

(b) BUSY lamp

The BUSY lamp lights while the PBMI and PBM are in access. Be sure not to unplug the PBM while this lamp is lit.

(c) Format Write

Before using a new PBM or clearing the contents of an old one, an initial format is written to the PBM. This operation should be performed as explained below.

STEP	Procedure
1.	Press the [BEGIN] key to activate the ADV function.
2.	Press these keys in order: [/] [1] [4] [EOL].

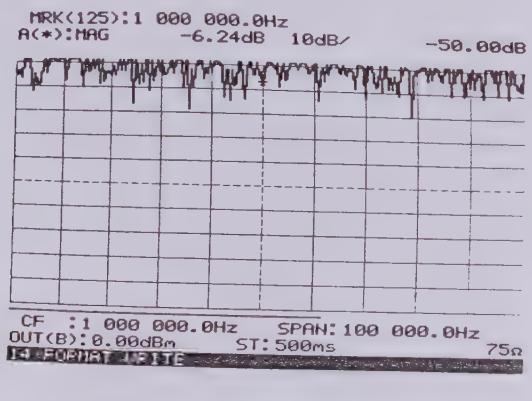


Fig. 2-43 Format Write (1)

3.	Press these keys in order: [G] [0] [EOL].

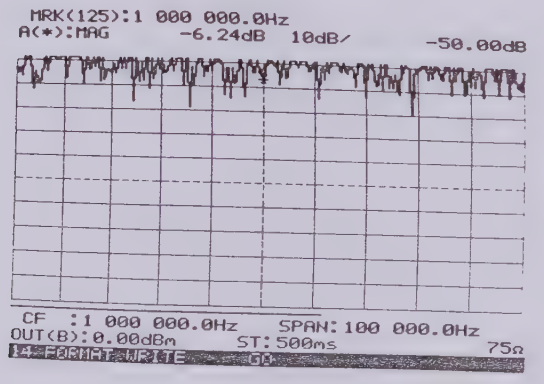


Fig. 2-44 Format Write (2)

4.	Wait until the BUSY lamp goes out.

Note

The BUSY lamp will stay lit for 1.5 to 3 seconds.

5.	Press the [RETURN] key.

(d) SAVE/RECALL (17)

The SAVE/RECALL key of MEMORY mode is used as follows.

Method	Operation
a	Press these keys in order: [SAVE] [MEM] [3] *.
b	Press these keys in order: [RECALL] [MEM] [5] *.

Note

1. *The part marked * is an address for which integers 0 to 5 must be used.*
2. *The BUSY lamp (2) will light for 1.5 to 3 seconds.*
3. *The panel setting status and the following memory contents can be stored.*
   SUB TRACE OFF: The contents of SA and SB memory
   SUB TRACE ON: The contents of SA memory and B memory

(e) BACK UP

After the PBM is plugged in, the Write Protect key is set to "Writable", and the following operation is carried out, the current panel setting status is stored in the PBM. This means that, even if the power is cut off by mistake, the previous status can be recalled merely by switching the power back on.

Setting the BACK UP function

Step	Procedure
1	Press the [BEGIN] key (17)
2	Press these keys in order: [/] [1] [5] [EOL].
3	Press these keys in order: [0] [N] [EOL].
4	Press the [RETURN] key (17).

Recalling back up data:

Press these keys in order: [RECALL] [MEM] [6].

Note

The contents of S and B memories are not backed up by the BACK UP function.

2.9 CONNECTING TEST DEVICES

The following explains the fundamental connections for each measurement item.

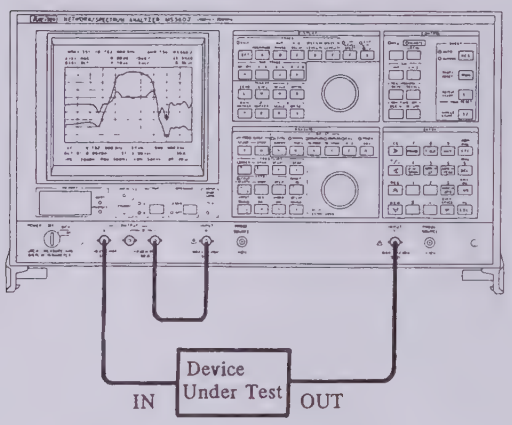


Fig. 2-45 MAG, PHA, DLY

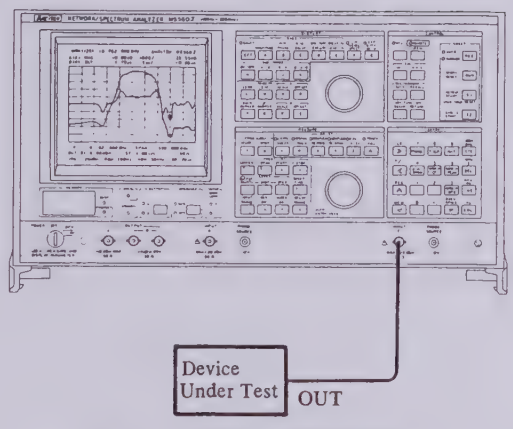


Fig. 2-46 LEVEL, SPECTRUM

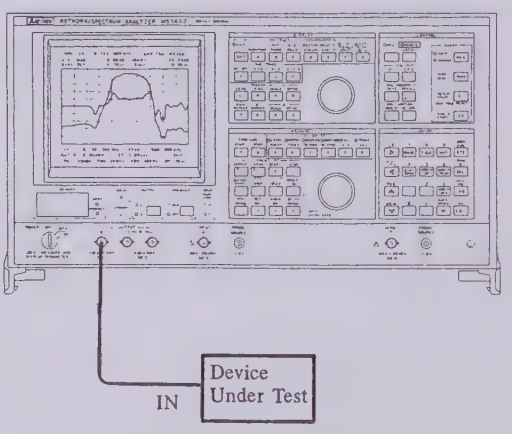


Fig. 2-47 Synthesizer

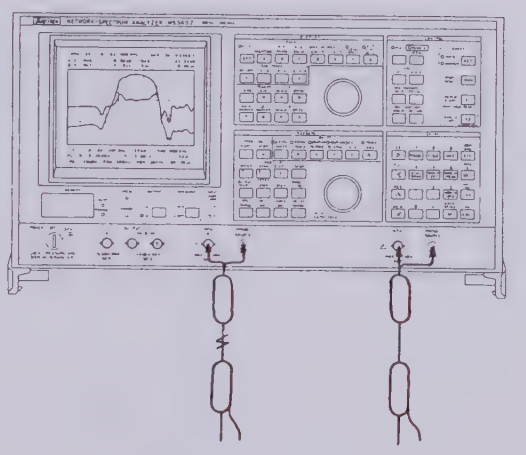


Fig. 2-48 AC probe

2.10 FUNCTION TEST

The following explains how to test very simply the fundamental functions of the MS560J. Refer to SECTION 6 for further details on confirming functions and performance.

(1) POWER ON

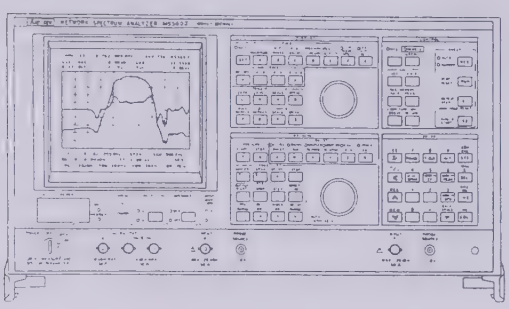


Fig. 2-49 Connection

With the power on, the waveform of Fig. 2-50 is displayed on the screen. See Fig. 2-19 for further details.

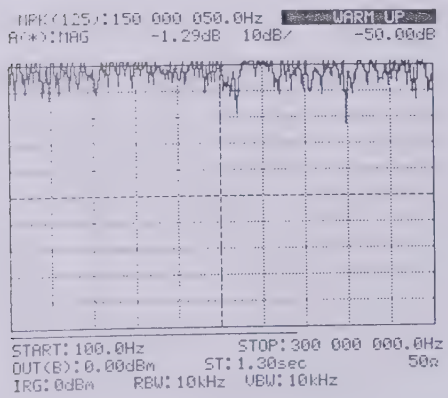


Fig. 2-50 Initial Display

Fifteen minutes after the power is turned on, "CALIBRATING" will be displayed on the upper right corner of the screen as shown in Fig. 2-51. When this message disappears, the MS560J is ready to take actual measurements.

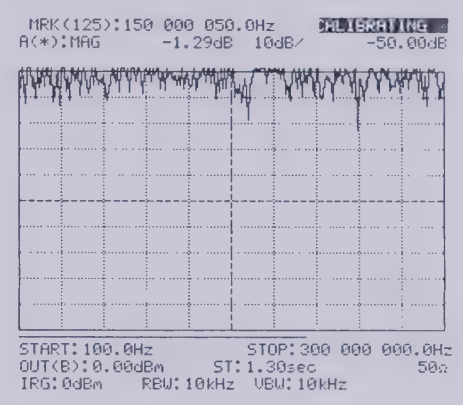


Fig. 2-51 CALIBRATING

(2) TRACE

The following are examples of screen displays when TRACE is changed by two different connections.

Table 2-7 TRACE

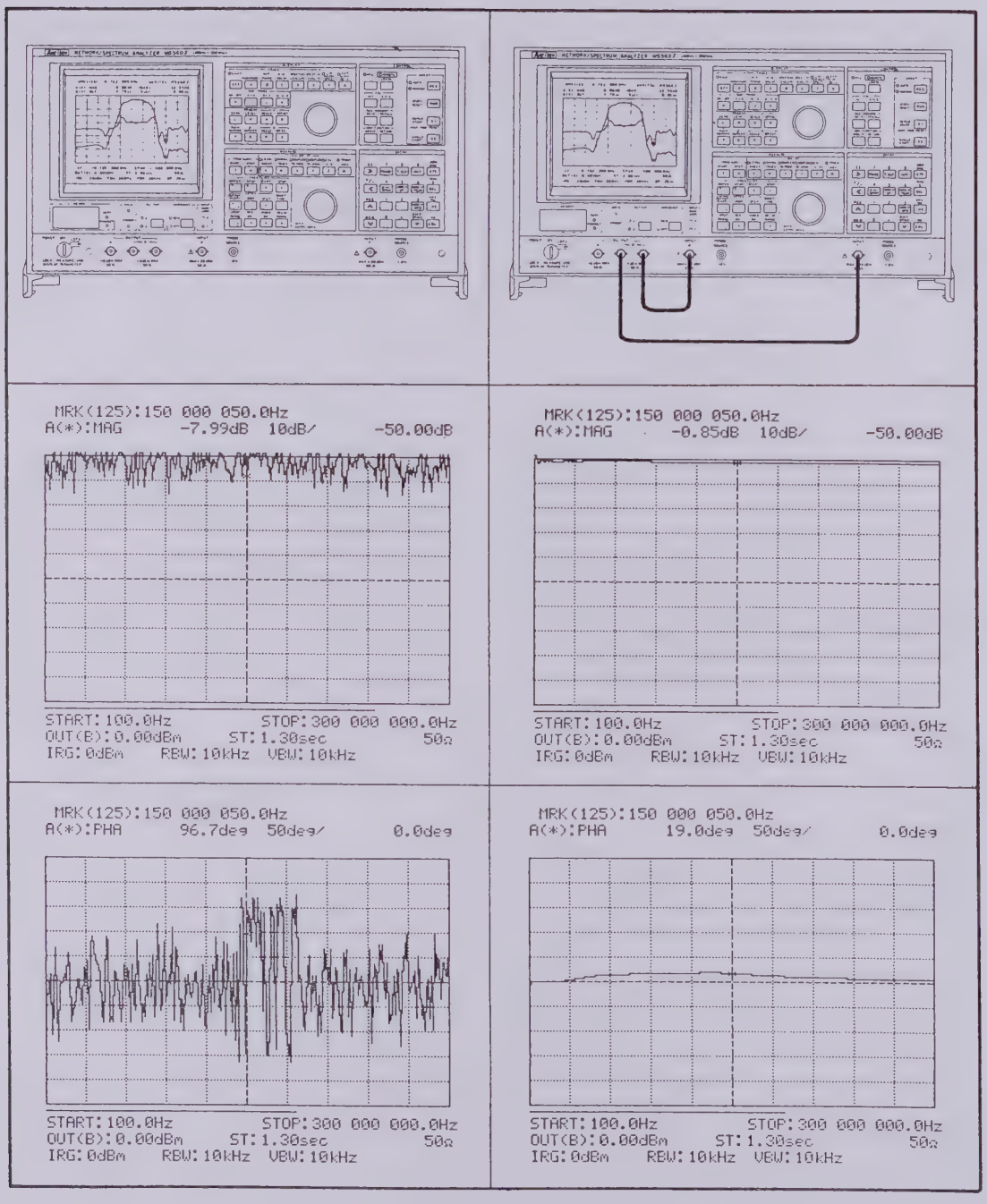
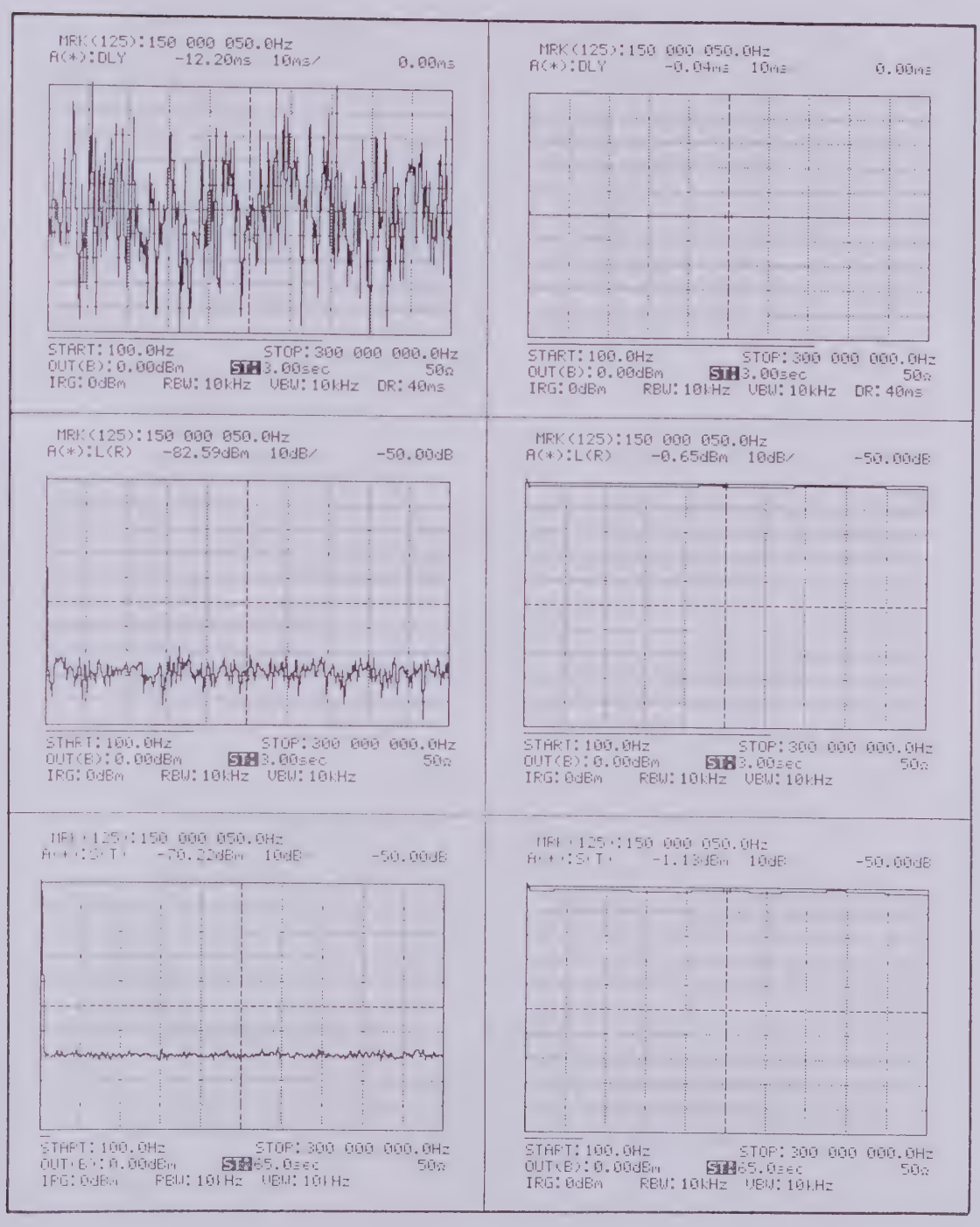


Table 2-7 TRACE (Cont'd)



(3) Calibration

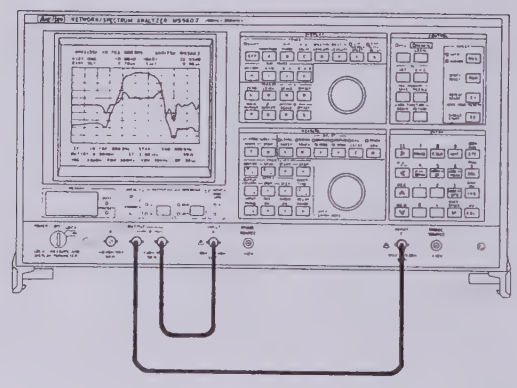


Fig. 2-52 Connection for Calibration

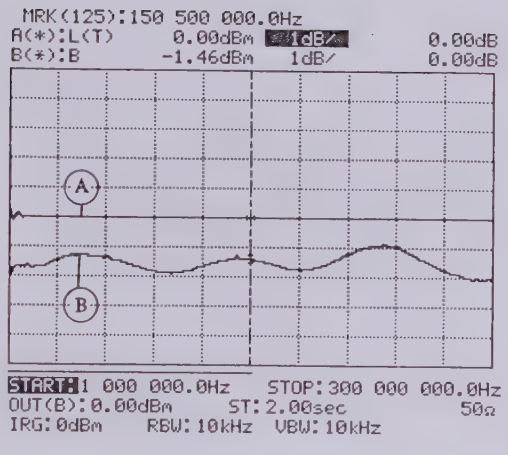


Fig. 2-53 Calibration Display

When magnitude is measured with the connection diagram shown in Fig. 2-52 waveform (B) of Fig. 2-53 is displayed on the screen. This measured value shows the frequency response of the MS560J itself. To eliminate this frequency response, do the following.

Step	Procedure
1.	Press the [X→S] key.
2.	Wait one sweep cycle.
3.	Turn the CAL X-S Lamp on.
4.	Wait for the waveform (A) shown in Fig. 2-53 to appear on the screen.
5.	If a measurement sample is connected after this, the measurement made will be correct.

Note

1. *If this calibration is made for measurements of magnitude, phase, and delay time when directly coupled circuits are connected, the measured value will be "0".*
2. *For measurements of level and spectrum, an absolute level is calibrated.*
3. *An level measurement error will show as "0" even when using this calibration. Refer to paragraph 3.2.3 and 3.2.4 for further details.*

(4) Dynamic range

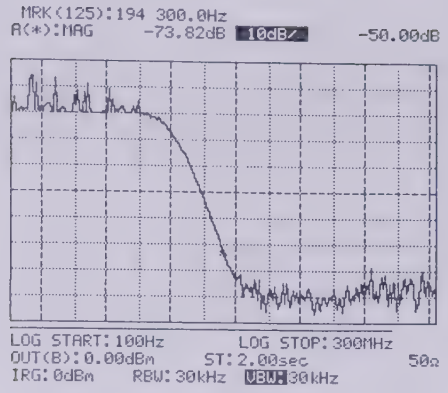


Fig. 2-54 RBW 30 kHz

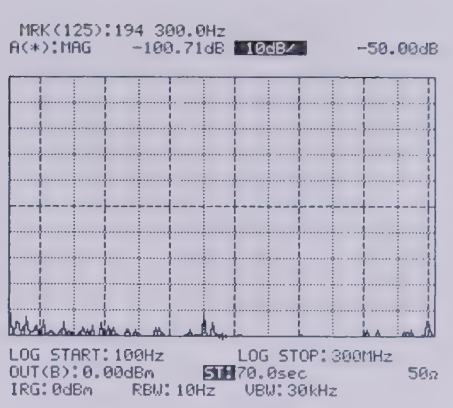


Fig. 2-55 RBW 10 Hz

RBW is the factor which determines the dynamic range. When the RBW is changed, the dynamic range varies as shown in Fig. 2-54 and 2-55. Fig. 2-56 shows the specification of a dynamic range. Measure the magnitude or level to confirm the above. As a rule, the smaller the RBW, the larger the dynamic range.

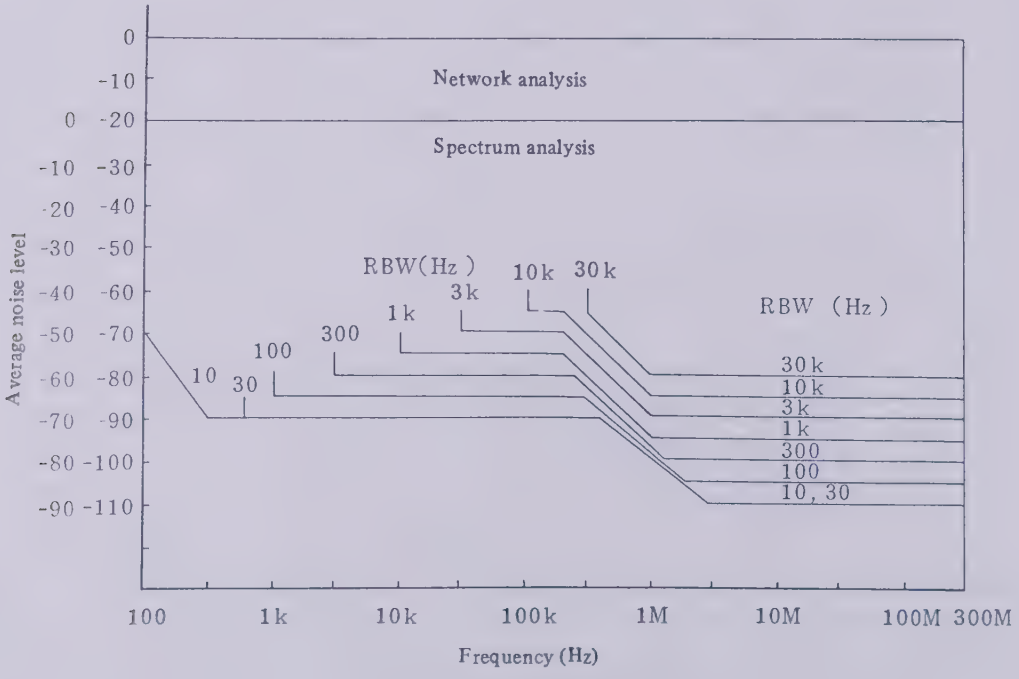


Fig. 2-56 Dynamic Range

(5) Level sweep

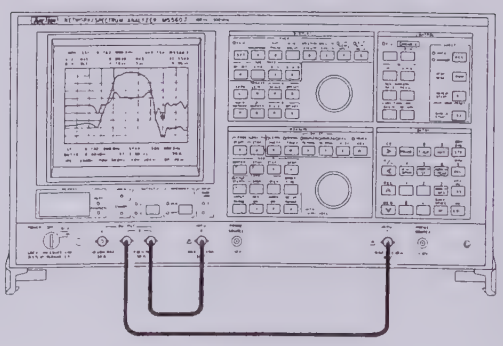


Fig. 2-57 Connection for Level Sweep

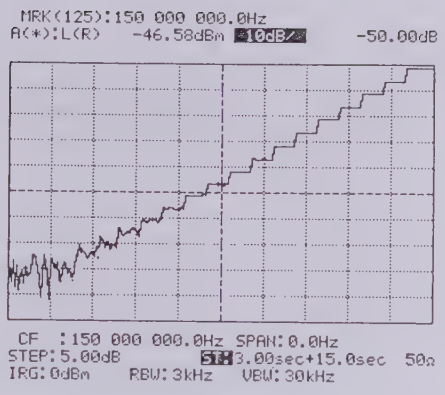


Fig. 2-58 Level Sweep (1)

If the following conditions are set with the connection shown in Fig. 2-57 and a level sweep is performed, the waveform shown in Fig. 2-58 is displayed on the screen.

TRACE ..... L (R)

OUT (START) ..... −100 dBm

STOP ..... 0 dBm

STEP ..... 5 dB

When changing the measuring item from TRACE L (R) to TRACE MAGNITUDE, the waveform shown in Fig. 2-59 is displayed on the screen.

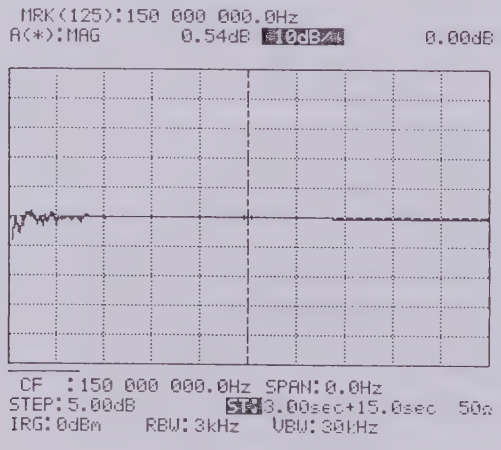
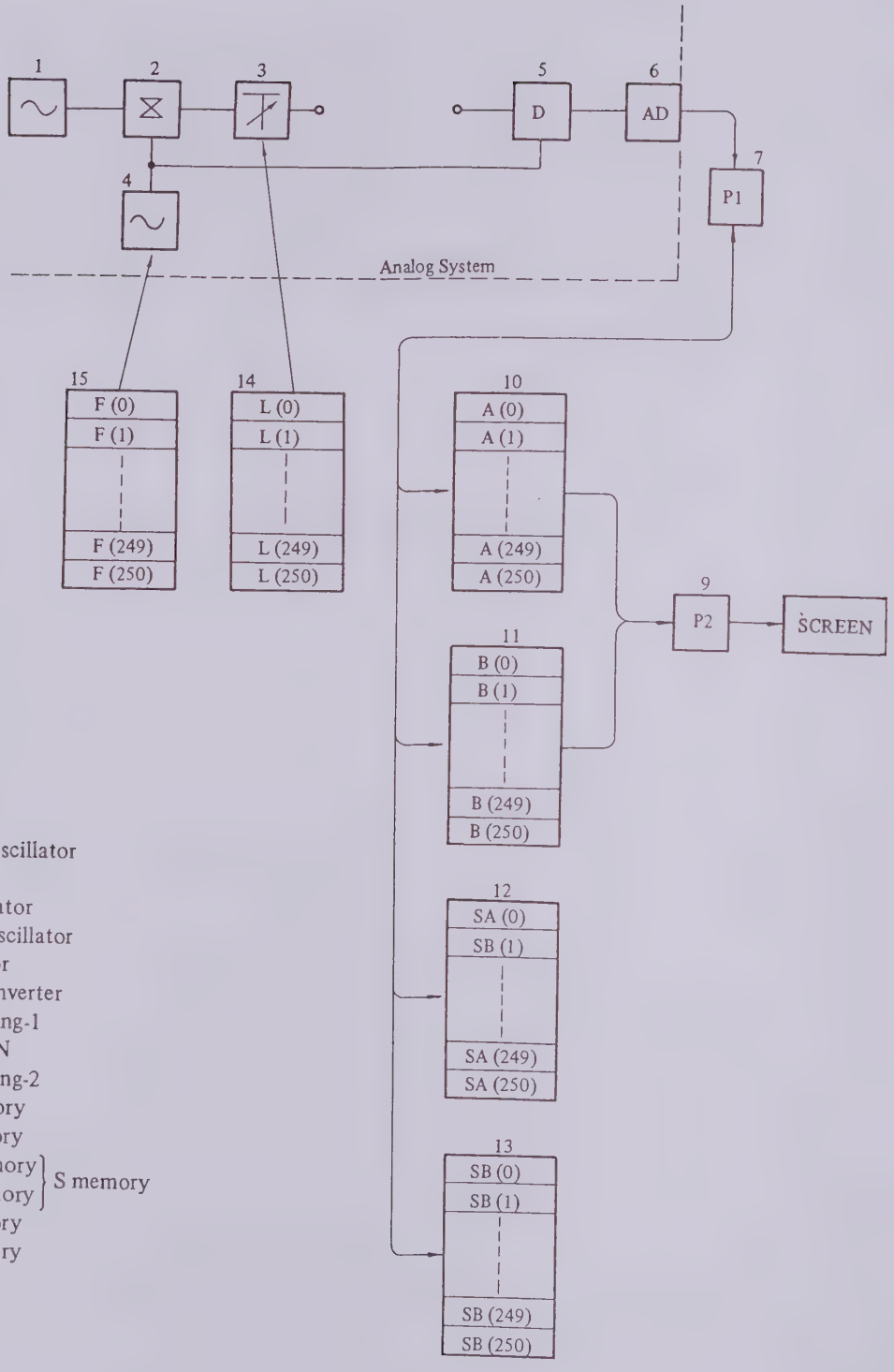


Fig. 2-59 Level Sweep (2)

2.11 MEMORY SYSTEM

The MS560J performs measurements on the basis of arrayed configuration memory. Descriptions are loaded in this memory system as described below. Figure 2-60 shows how this system is connected to an analog system. The flow of measurements based on this figure is shown in Fig. 2-61. The X values (measured values at each point) in the figure are stored in memories A, B, SA, and SB through the flow shown in Table 2-8. P2 processing as shown in the table is the adjustment of SCALE and OFFSET.

Figure 2-62 shows the operating functions for these memories. This figure shows how to control an element of each memory by peripheral units. For example, if the GP-IB and PTA1 option are used, it means that all memories can be operated freely. Control of the F and L memories from the front panel is limited. Refer to paragraph 2.8 for further details.



Notes:

1. Fixed oscillator
2. Mixer
3. Attenuator
4. Local oscillator
5. Detector
6. A/D converter
7. Processing-1
8. SCREEN
9. Processing-2
10. A memory
11. B memory
12. SA memory } S memory
13. SB memory }
14. L memory
15. F memory

Fig. 2-60 Memory Configuration

Table 2-8 Data Flow

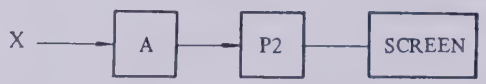
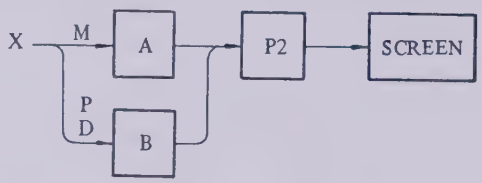
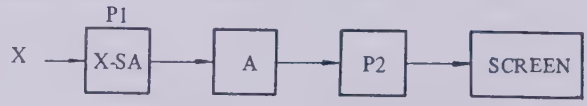
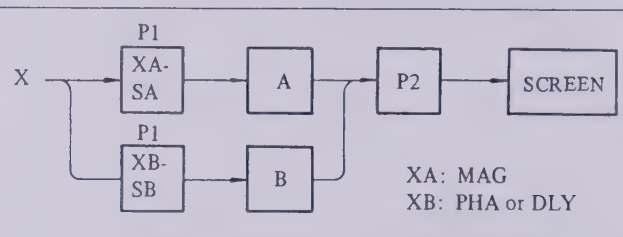
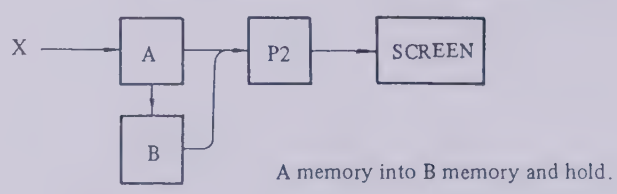
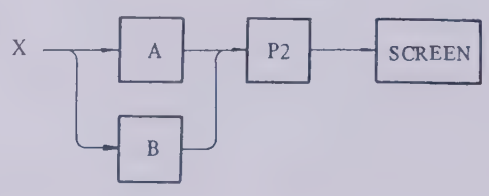
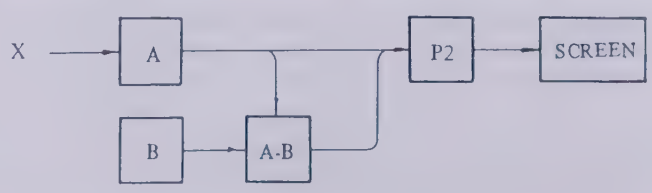
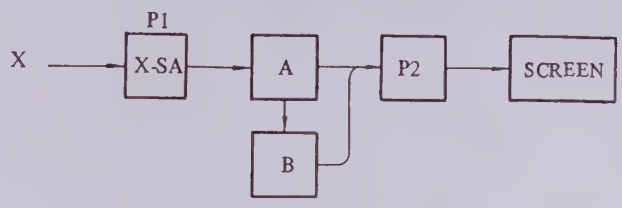
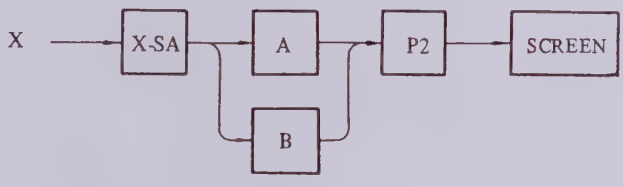
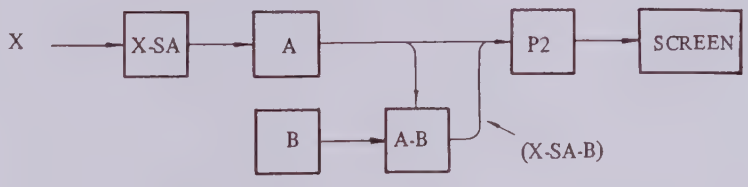
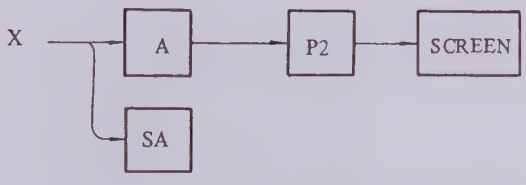
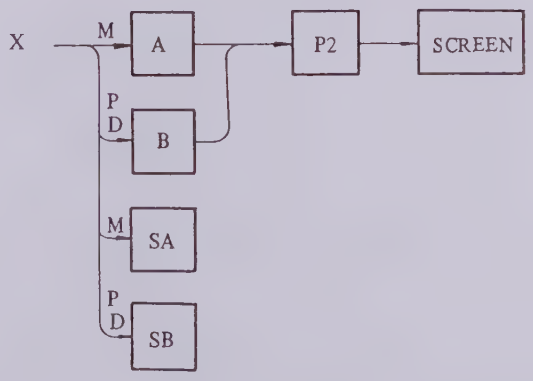
Functions			Data flow
MAG, PHS, DLY, LEVEL, SPECT X-S; OFF SUB TRACE: OFF			
M/P, M/D X-S; OFF SUB TRACE: OFF			
MAG, PHS, DLY, LEVEL, SPECT X-S; ON SUB TRACE: OFF			
M/P, M/D X-S; ON SUB TRACE: OFF			
MAG PHS DLY LEVEL SPECT SUB TRACE : ON	X-S: OFF	A→B	
		B = A	
		B = A – B	

Table 2-8 Data Flow (Cont'd)

Functions			Data flow
MAG PHS DLY LEVEL SPECT SUB TRACE: ON	X-S: ON	A → B	
		B = A	
		B = A – B	
MAG, PHS, DLY, LEVEL, SPECT One sweep after pressing the [X → S] key.			
M/P, M/D One sweep after pressing the [X → S] key.			

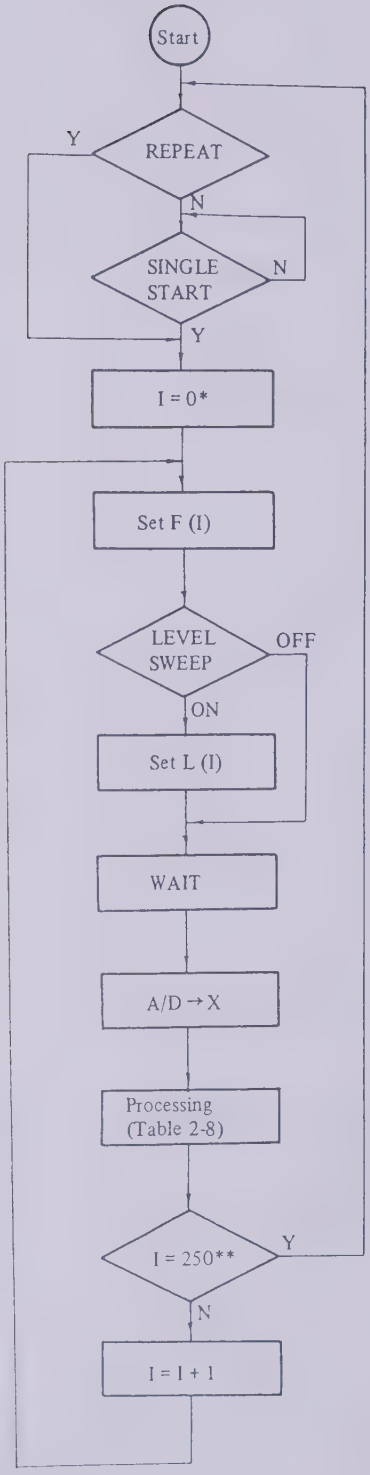
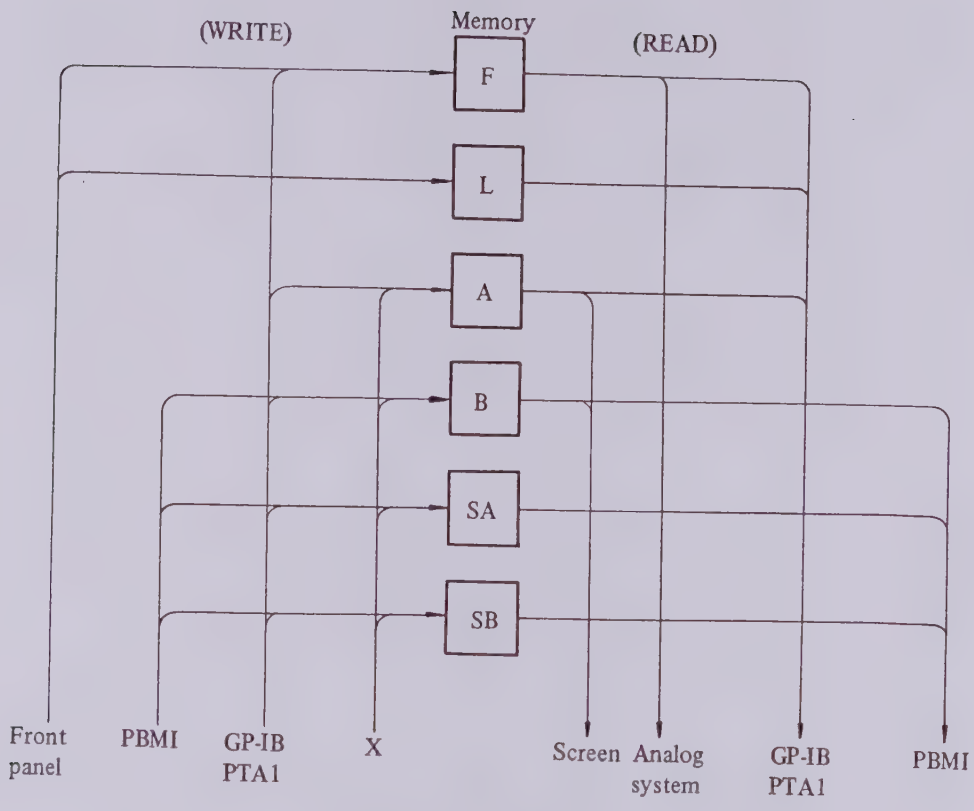


Fig. 2-61 Measurement Flowchart

Note

1. For marker sweep operation, * and ** become the value at the marker point.
2. For Δ marker sweep operation, * and ** are the start and stop points, respectively.



Variable name

	GP-IB	PTA1
F	FQ, FQR, MMR	F
L	LV, LVR, MMR	L
A	XA, XAR	XA
B	XB, XBR	XB
SA	SA, SAR	XSA
SB	SB, SBR	XSB

Fig. 2-62 Memory Access

SECTION 3 MEASUREMENT

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SECTION 3 MEASUREMENT

3.1 NETWORK ANALYSIS

3.1.1 Principles of Analysis

A network's transmission and reflection characteristics are often used to delineate the network's properties. The MS560J measures a frequency response of the magnitude, phase, and delay time and displays these values on the screen A network's reflection characteristics can be measured by combining a reflection bridge with the MS560J;

(1) Transmission characteristics

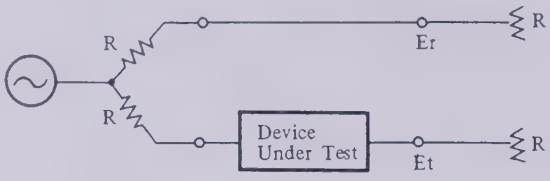


Fig. 3-1 Transmission Characteristics

In Fig. 3-1, the relation between Er and Et is as follows:

$$\frac{Et}{Er} = |K| \cdot e^{j\phi} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.1),$$

where |K| is the amplitude ratio (called MAGNITUDE) and ϕ is the phase shift called PHASE (rad). From formula 3.1, magnitude A, phase θ, and delay time τ are as below:

$$A = 20 \log |K| \quad \text{(dB)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.2)$$

$$\theta = \frac{360}{2\pi}\phi \quad \text{(deg)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.3)$$

$$\tau = \frac{d\phi}{d\omega} \quad \text{(S)}$$

$$\simeq \frac{\Delta\phi}{\Delta\omega} = -\frac{1}{360} \cdot \frac{\Delta\theta}{\Delta F} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.4),$$

where ϕ = phase (rad), ω = angular frequency, $\Delta\theta$ = phase difference (deg), and ΔF = frequency difference (Hz). The magnitude and phase are measured directly and displayed on the screen.

The delay time can be obtained by measuring the phase difference $\Delta\theta$ between two the frequencies, $f_0 + \frac{\Delta F}{2}$ and $f_0 - \frac{\Delta F}{2}$, and calculating with formula 3.4.

ΔF is called the aperture frequency and its relationship to DR, the resolution, and the measuring range are shown in Table 3-1.

In the EXPAND mode, the resolution is 1/10 times of normal mode, and measuring time is increased by inserting the integrator, automatically.

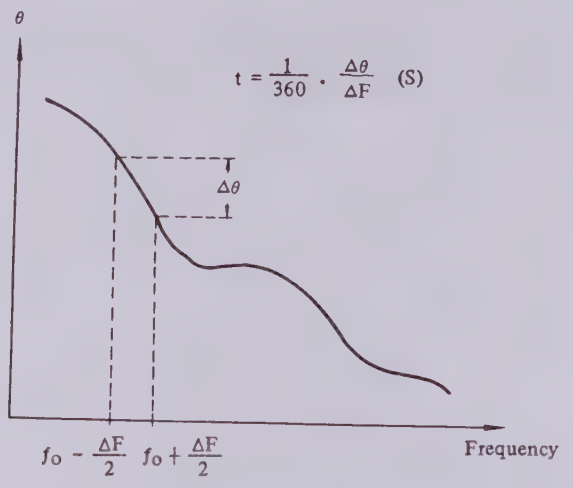


Fig. 3-2 Measurement of Delay Time

Table 3-1 Measurement of Delay Time

Range	Aperture ΔF	NORMAL		EXPAND		Frequency range	
		Range	Resolution	Range	Resolution		
100 nS	4 MHz	±100 nS	0.1 nS	±10 nS	0.01 nS	10 MHz	~ 300 MHz
200	2	±200	0.2	±20	0.02	5	~ 300 MHz
400	1	±400	0.4	±40	0.04	2.5	~ 300 MHz
1 μS	400 kHz	±1 μS	1	±100	0.1	1	~ 300 MHz
2	200	±2	2	±200	0.2	500 kHz	~ 300 MHz
4	100	±4	4	±400	0.4	250 kHz	~ 300 MHz
10	40	±10	10	±1 μS	1	100 kHz	~ 300 MHz
20	20	±20	20	±2	2	50 kHz	~ 300 MHz
40	10	±40	40	±4	4	25 kHz	~ 300 MHz
100	4	±100	100	±10	10	10 kHz	~ 300 MHz
200	2	±200	200	±20	20	5 kHz	~ 300 MHz
400	1	±400	400	±40	40	2.5 kHz	~ 300 MHz
1 mS	400 Hz	±1 mS	1 μS	±100	100	1 kHz	~ 300 MHz
2	200	±2	2	±200	200	500 Hz	~ 300 MHz
4	100	±4	4	±400	400	250 Hz	~ 300 MHz
10	40	±10	10	±1 mS	1 μS	140 Hz	~ 300 MHz
20	20	±20	20	±2	2	120 Hz	~ 300 MHz
40	10	±40	40	±4	4	110 Hz	~ 300 MHz

(2) Reflection characteristics

If the impedance of device under test and reference impedance are Zx and Ro, respectively, the reflection coefficient S is determined as follows:

$$S = |S| \cdot e^{j\phi} = \frac{Zx - Ro}{Zx + Ro} \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (3.5)$$

$$\theta = \frac{360}{2\pi}\phi \quad \text{(deg)} \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (3.6)$$

$$\delta = 20 \log_{10} \frac{1}{|S|} \quad \text{(dB)} \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (3.7)$$

S is detected with a reflection bridge, and δ, θ are measured with the MS560J. All values are displayed on the screen.

(3) Impedance

Two terminal impedance can be measured with the Impedance Probe MA413A.

3.1.2 Magnitude

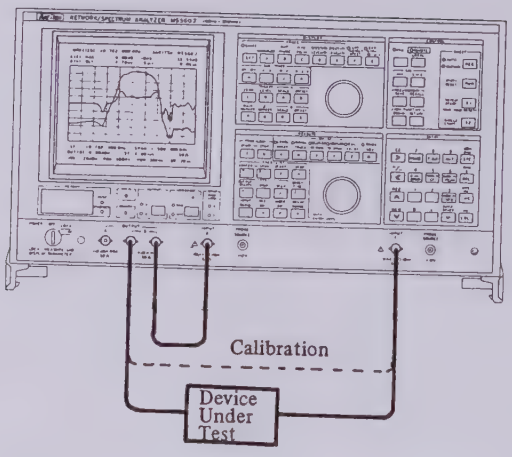


Fig. 3-3 Magnitude Measurement Connections

Magnitude is one of the fundamental measurements when determining transmission characteristics. This paragraph explains how to set the RBW for the optimal dynamic range, and the sweep time (ST) magnitude measurements. This example assumes the device under test is a band pass filter with a 1.5 MHz center frequency.

(1) Procedures

Step	Procedure
1	Turn the power on.
2	Confirm that the following items are set when the power is on.

- OUTPUT . . . . . B
- IMPEDANCE 50Ω
- LEVEL-OUTPUT . . . . . 0 dBm
- LEVEL SWEEP . . . . . OFF
- COUPLED TO FREQ . . . . . OFF
- TRACE . . . . . MAGNITUDE

Note

After the power is on, press the [RECALL] and [9] keys in that order to initialize the MS560J.

Step	Procedure

3 Set the frequency as indicated below:

Center frequency (CF): 1.5 MHz
SPAN: 5 kHz

4 Check the OVERLOAD lamp and set the IRG as follows:

When on: Increase IRG until the lamp goes out.
When off: Decrease IRG as much as possible without turning the lamp on.

5 Set RBW as indicated below.

Lowest frequency	RBW
≦ 100 Hz	3 Hz
≦ 300 Hz	3 Hz, 10 Hz
≦ 1 kHz	3 Hz to 30 Hz
≦ 3 kHz	3 Hz to 100 Hz
≦ 10 kHz	3 Hz to 300 Hz
≦ 30 kHz	3 Hz to 1 kHz
≦ 100 kHz	3 Hz to 3 kHz
≦ 300 kHz	3 Hz to 10 kHz
> 300 kHz	3 Hz to 30 kHz

6 Make the VBW setting wider than the RBW setting.

Note

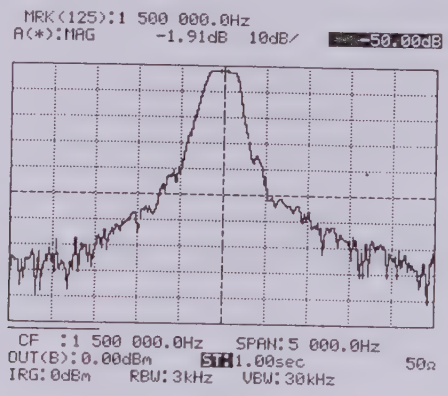
See paragraph 3.6.1.(b) for details of the VBW.

7. Check the UNCAL lamp. If it is on, increase ST until it goes out (Fig. 3-4).

Note

If the setting time of the device under test is greater than ST, it is necessary to further increase ST to a point where the trace on the screen does not change (Fig. 3-5).

Step	Procedure



UNCAL: OFF

Fig. 3-4 ST Adjustment (A)

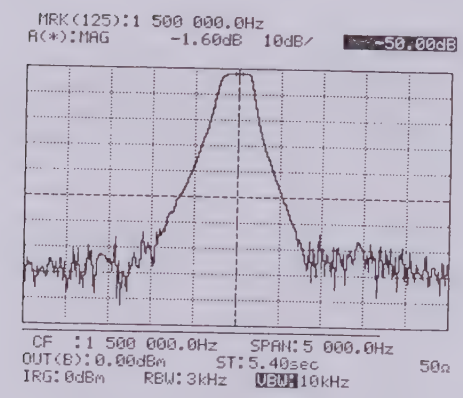


Fig. 3-5 ST Adjustment (B)

8 Connect OUTPUT B to INPUT T directly (dotted line in Fig. 3-3) and press the [X → S] key.

9 After one sweep measurement, connect a device under test.

10 Turn the X – S lamp on.

Note

If the frequency, IRG, and RBW are changed, restart the operation from step 8.

11 Read the measured values on the screen.

(2) Level setting

The MS560J can measure over a very wide range of levels. Since the characteristics of the circuit being measured (irrespective of its being an active or passive circuit) may change according to the measuring level used, a proper measuring level should be determined by one of the following condition.

- A device under test should be tested in actual operating status.
- A device under test should be tested at a level without distortion.

Fig. 3-6 is the level diagram of the MS560J measuring system.

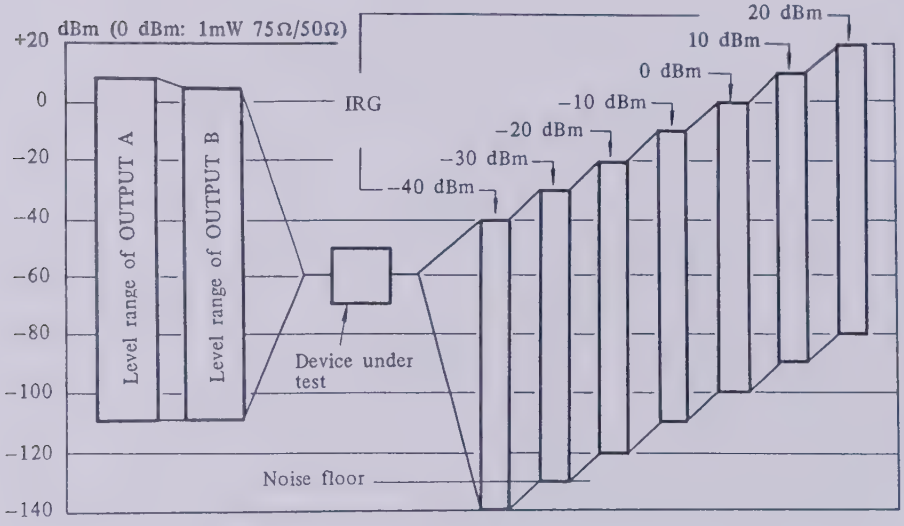
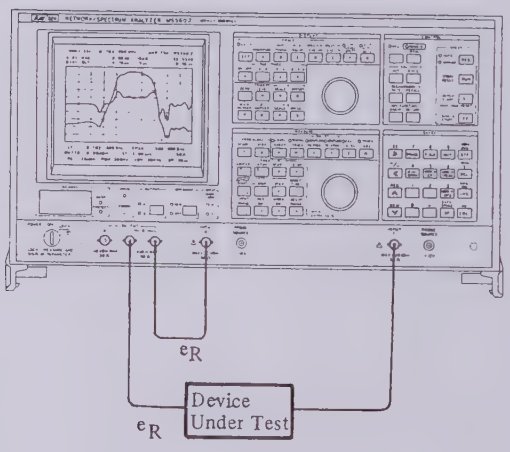


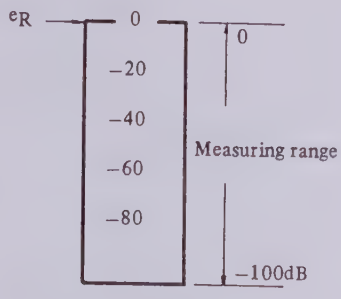
Fig. 3-6 Level Diagram of the MS560J Measuring System

(3) Selecting an effective dynamic range

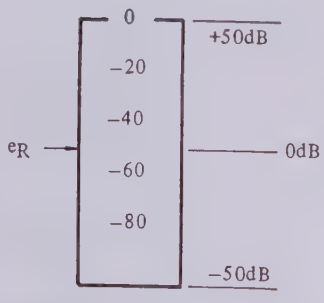
The MS560J has up to 100 dB dynamic range. Use the following level settings to make the best use of the dynamic range.

- Loss circuit: Used to equalize the output level (e_R) of a synthesizer with the input range (IRG).
- Gain circuit: Used to make the output level (e_R) of a synthesizer using the maximum gain of the measuring band smaller than the input range (IRG).





Loss circuit (Filter)



Gain circuit (Amplifier)

Fig. 3-7 Selecting an Effective Dynamic Range

If the loss of the impedance converter used for a device under test having an impedance other than 50 Ω is too large, the measured dynamic range will be narrow.

In such cases, insert a resistance attenuator in the channel R route as shown in Fig. 3-8, and then this attenuation should be equal to the insertion loss of device under test including the impedance converter. This will allow for use of a lower IRG (Fig. 3-6.)

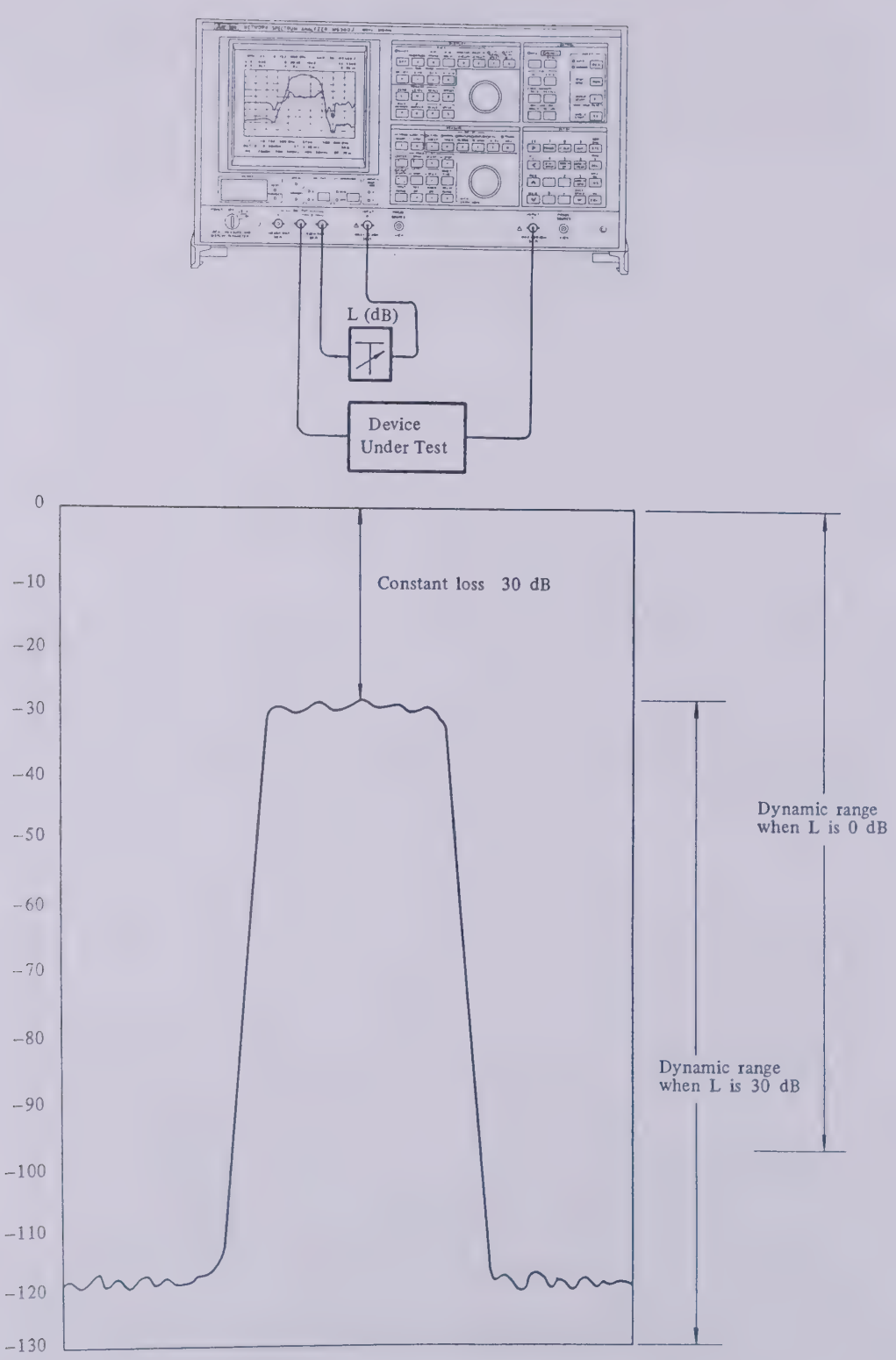


Fig. 3-8 Improving the Dynamic Range

(4) TRACK ADJ

When RBW is 3 Hz or 10 Hz, it is advisable to occasionally check TRACK ADJ to ensure accuracy. In such case, see paragraph 2.8 – (29) for more information.

3.1.3 Phase, Magnitude/Phase

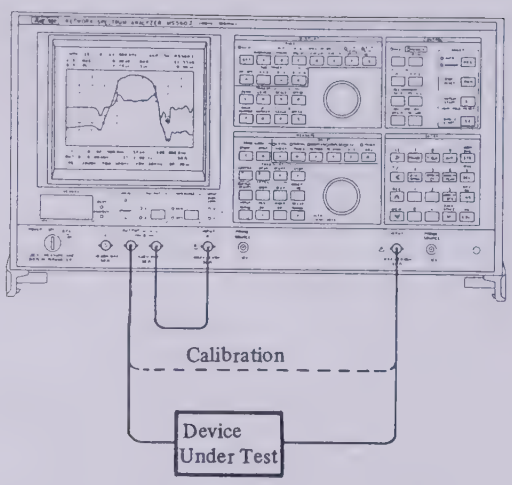


Fig. 3-9 Phase Measurement Connections

When magnitude is measured under the correct conditions, phase will be measured accurately. This paragraph explains the general operating procedures used for making a phase measurement of a band-pass filter with a 1.5 MHz center frequency.

For magnitude/phase measurements, the procedures for magnitude measurement are nearly the same as those given in paragraph 3.1.2. The only difference between the phase and magnitude/phase measurement procedures is that phase measurement makes use of OFFSET and SCALE of the B-channel for waveform adjustments.

(1) Procedures

Step	Procedure
1	Turn the power on.
2	Confirm that the following items are set when the power is on. • OUTPUT . . . . . B • IMPEDANCE . . . . . 50 Ω • LEVEL – OUTPUT . . . . . 0 dBm • LEVEL – SWEEP . . . . . OFF • COUPLED TO FREQ . . . . . OFF

Note

After the power is on, press the [RECALL] *and* [9] *keys in that order to initialize the MS560J*

Step	Procedure

3 Press the [PHASE] key of the TRACE. The SHIFT lamp should go out.

Note

For magnitude/phase, turn the SHIFT lamp on.

4 Set the frequency.

CF: 1.5 MHz
SPAN: 2 kHz

5 Watch the OVER LOAD lamp while setting the IRG level as indicated below:

When the lamp is on: Increase IRG until the lamp goes out.
When the lamp is off: Decrease IRG as far as possible without turning the lamp on.

6 Set RBW as indicated below.

Lowest frequency	RBW
≦ 100 Hz	3 Hz
≦ 300 Hz	3 Hz, 10 Hz
≦ 1 kHz	3 Hz to 30 Hz
≦ 3 kHz	3 Hz to 100 Hz
≦ 10 kHz	3 Hz to 300 Hz
≦ 30 kHz	3 Hz to 1 kHz
≦ 100 kHz	3 Hz to 3 kHz
≦ 300 kHz	3 Hz to 10 kHz
> 300 kHz	3 Hz to 30 kHz

7 Make the VBW setting wider than the RBW setting.

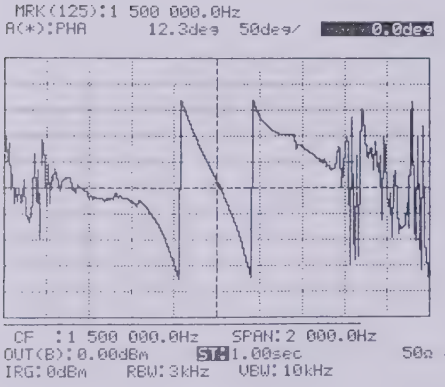
Note

See paragraph 3.6.1 – (b) for VBW.

Step	Procedure
8	If the UNCAL lamp is found to be on after checking, increase ST until it goes out (Fig. 3-10).

Note

If the setting time of the device under test is greater than ST, it is necessary to further increase ST to a point where the trace on the screen does not change (Fig. 3-11)



UNCAL: OFF

Fig. 3-10 ST Adjustment (A)

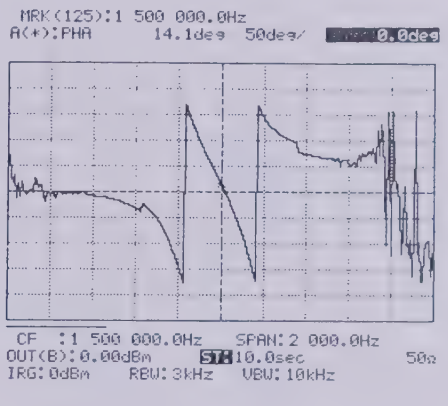


Fig. 3-11 ST Adjustment (B)

9	Connect OUTPUT B to INPUT T directry and press the [X → S] key.
10	Once a single sweep measurement finishes, connect a device under test.
11	Turn the X – S lamp on.

Note

If the frequency, IRG, and RBW are changed, repeat the operations from step 9.

12	Read the measured value on the screen.

Note

See the following paragraph if necessary.

- *Setting measurement level:* *Paragraph 3.1.2 – (2)*
- *Setting effective dynamic range:* *Paragraph 3.1.2 – (3)*
- *TRACK ADJ:* *Paragraph 2.8 – (29)*

3.1.4 Delay Time, Magnitude/delay Time

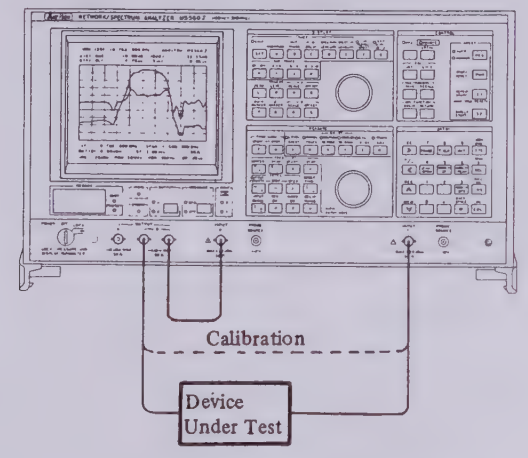


Fig. 3-12 Connections for Delay Time Measurement

The MS560J provides two kinds of delay time measurement modes.

The NORMAL mode is used for general delay time measurements. The EXPAND mode is used when the device under test has a long absolute delay time and frequency response which are too small to be measured with adequate resolution, or when a resolution below 1 ns is required.

For magnitude/delay time measurements, the magnitude measurement procedures are the same as those given in Section 3.1.2. The differences between delay time measurement procedures are explained in Note.

(1) Procedures (NORMAL mode)

Step	Procedure
1	Turn the power on.
2	Confirm that the following items are set when the power is on. • OUTPUT . . . . . B • IMPEDANCE . . . . . 50 Ω • LEVEL-OUTPUT . . . . . 0 dBm • LEVEL-SWEEP . . . . . OFF • COUPLED TO FREQ . . . . . OFF *Note* *If the save function has not been used after the power is on, press the* [RECALL] *and* [0] *keys in that order to initialize the MS560J.*
3	Set the frequency. CF: 1.5 MHz SPAN: 1 kHz
4	Press the [DELAY] key of the TRACE. *Note* *Turn the SHIFT lamp on for magnitude/delay time measurement.*
5	Turn the EXP lamp off.
6	Check the OVERLOAD lamp and set IRG as follows: When on: Increase IRG until the lamp goes out. When off: Decrease IRG as far as possible without turning the lamp on.

Step	Procedure

7 Set RBW as indicated below.

Lowest frequency	RBW
≦ 100 Hz	3 Hz
≦ 300 Hz	3 Hz, 10 Hz
≦ 1 kHz	3 Hz to 30 Hz
≦ 3 kHz	3 Hz to 100 Hz
≦ 10 kHz	3 Hz to 300 Hz
≦ 30 kHz	3 Hz to 1 Hz
≦ 100 kHz	3 Hz to 3 kHz
≦ 300 kHz	3 Hz to 10 kHz
> 300 kHz	3 Hz to 30 kHz

8 Make the VBW setting wider than the RBW setting

Note

See Paragraph 3.6.1 – (b) for VBW.

9 Set ST so that the UNCAL lamp is off.

10 Decrease the DR gradually from 400 ms. The waveform on the screen should change from that shown in Fig. 3-13 to that in Fig. 3-14.

Fix the DR once the waveform shown in Fig. 3-14 appears on the screen.

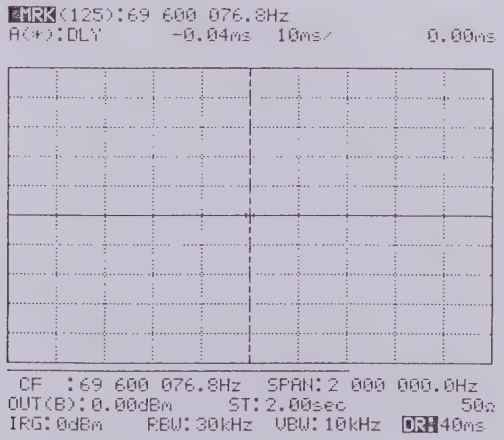


Fig. 3-13 DR Adjustment (A)

Step	Procedure

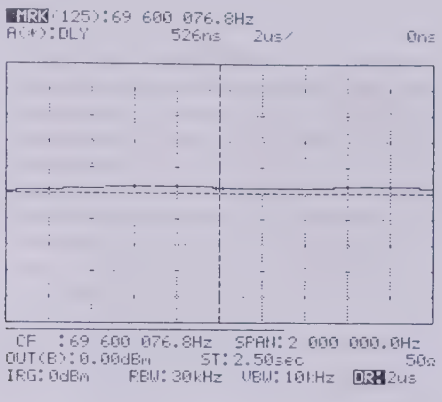


Fig. 3-14 DR Adjustment (B)

11 Press the [A-SCALE] key.

Note

Press the [B-SCALE] key for magnitude/delay time measurement.

12 Set the SCALE so that the waveform on the screen increases to the size shown Fig. 3-15.

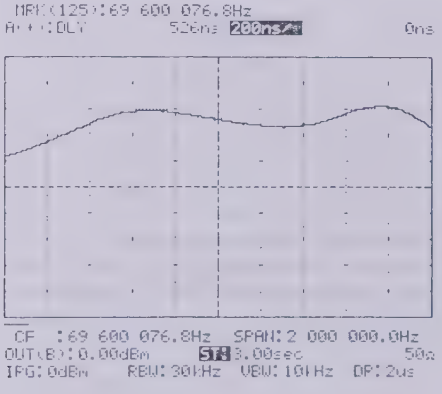


Fig. 3-15 Scale Adjustment

Step	Procedure
13	Adjust the ST so that the UNCAL lamp does not light.

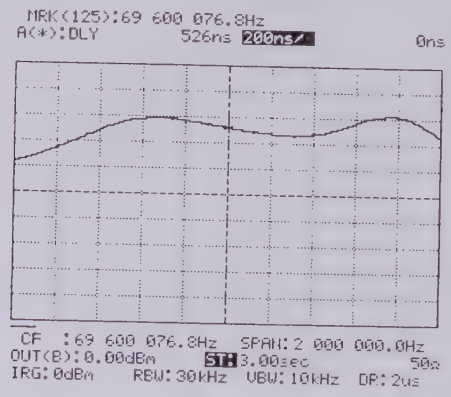


Fig. 3-16 ST Adjustment

14 If DR changes at this time, the waveform on the screen may vary from that shown in Fig. 3-17 to that in Fig. 3-18. To reduce measuring errors as much as possible set the minimum DR where the peak values as shown in Fig. 3-18 (asterisked part) are largest and also stop to changing.

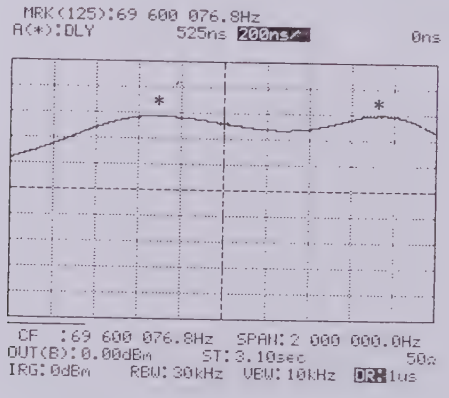


Fig. 3-17 DR Adjustment (C)

Step	Procedure

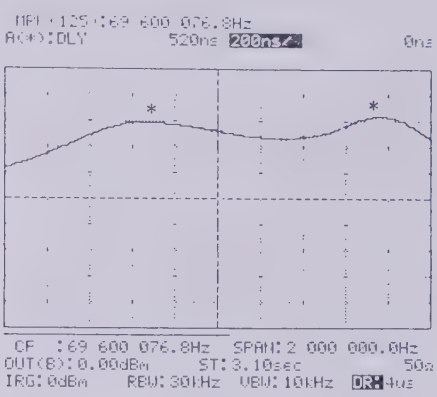


Fig. 3-18 DR Adjustment (D)

15 Read the measured values on the screen.

Use Δ marker for frequency response.

(2) Procedure (EXPAND mode)

Step	Procedure
1 to 14	The same as for NORMAL mode.
15	Press the [A-OFFSET] key.

Note

Press the [B-OFFSET] key for magnitude/delay time measurement.

16 Set the offset so that the center value of the expanded part is displayed on the center of the screen. (Fig. 3-19)

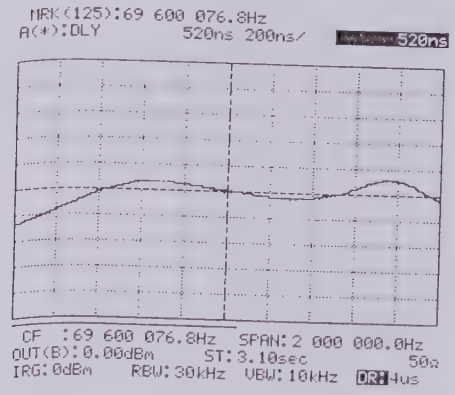


Fig. 3-19 Offset Adjustment

17 Press the [EXP] key. At this point, ST is increased.

18 Press the [A-SCALE] key.

Note

Press the [B-SCALE] key for magnitude/delay time measurement.

Step	Procedure

19 Set the scale so that the waveform on the screen is large enouth to be seen easily. (Fig. 3-20)

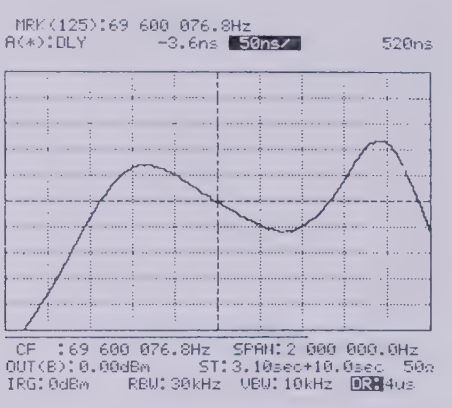


Fig. 3-20 SCALE Adjustment

20 Read the measured values on the screen. Note that, in this mode, the values at each display point on the screen are not valid. Only the inter-point relative values (frequency response) are effective (Fig. 3-21). For that reason, absolute delay time must be measured in NORMAL mode.

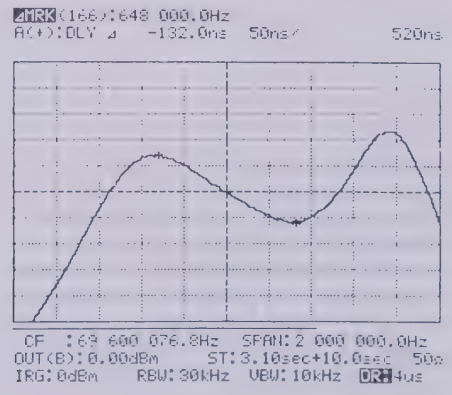


Fig. 3-21 Δ Marker

(3) Calibration

Usually, frequency response of the measuring system need not be calibrated when in NORMAL mode.

In EXPAND mode the frequency response of the measuring system sometimes lead to problems and the calibration procedures are different from the magnitude and phase measurement. With this in mind, the calibration method explained here in premised on all measuring conditions of the EXPAND mode being set.

Step	Procedure
1	Connect OUTPUT B to INPUT directly.
2	Note for later the present offset values and then set the offset to 0.
3	Press the [X → S] key.
4	Turn the X – S lamp on.
5	Connect the device under test.
6	Restore the original offset value.
7	Calibrated values of the measuring systems frequency response are displayed on the screen.
	Measure only the frequency response, reading the values with the Δ marker.

(4) Misoperation

This item covers the causes of and recovery procedures for operation mistakes which are possible during delay time measurement.

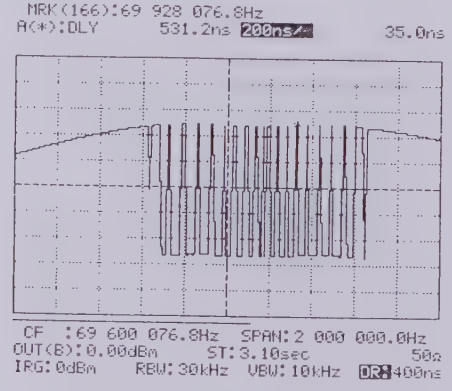


Fig. 3-22 Too small a DR

(a) Increase the DR. (Fig. 3-22)

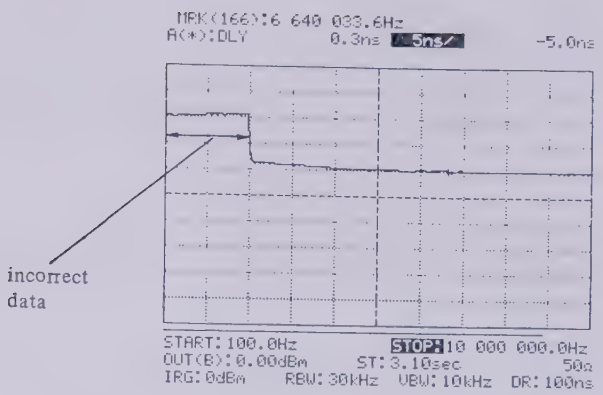


Fig. 3-23 Too low a frequency

(b) The lowest frequency is too low for the DR. (Fig. 3-23)

(c) The sweep time is long while ST is small. This occurs when SPAN or RBW is very narrow. Once the conditions are set correctly, the sweep time will be normal.

(d) The sweep stops mid-way. This is normal.

Note

See the following paragraph if necessary

- *Setting measurement level:* *Paragraph 3.1.2–(2)*
- *Setting effective dynamic range:* *Paragraph 3.1.2–(3)*
- *TRACK ADJ:* *Paragraph 2.8–(29)*

3.2 LEVEL AND SPECTRUM MEASUREMENT

3.2.1 Principles of Measurement

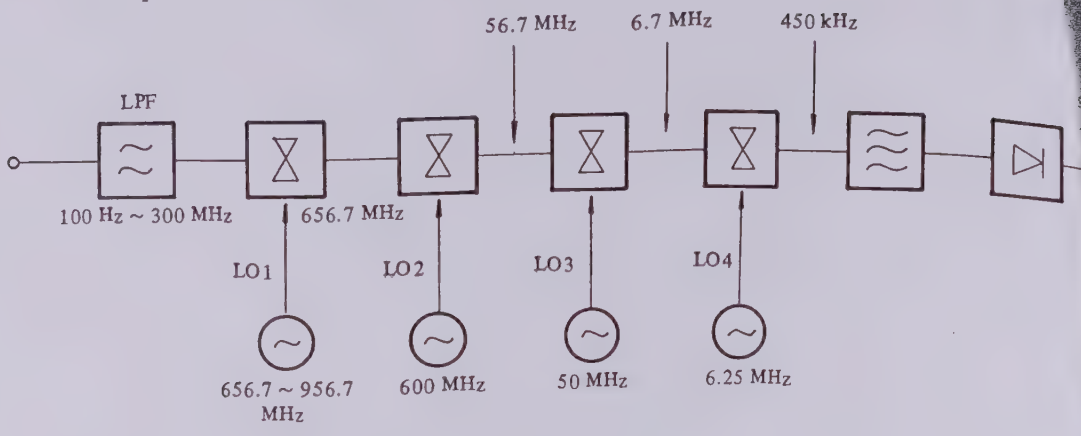
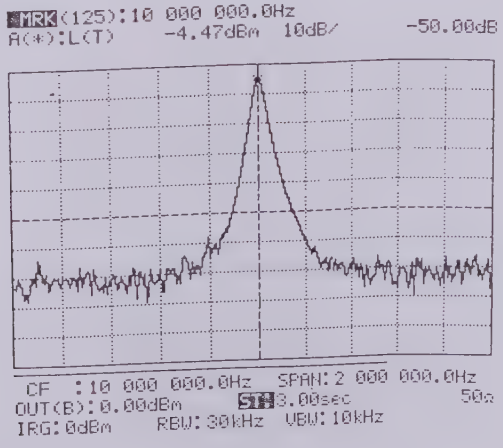


Fig. 3-24 Receiving Section

The receiving section of the MS560J consists of a quadruple superheterodyne system receiver, as shown in Fig. 3-24. The frequency spectrum of an input signal can be displayed on the screen, when sweeping the 1st local (LO1) and indicating frequencies on the horizontal axis and the detection output of the IF signal on the IF signal on the vertical axis.

The 1st local is a synthesizer and is swept digitally. This sweep operation is performed in either LEVEL or SPECTRUM mode. The LEVEL mode is used for general measurements and the SPECTRUM mode is used when the RBW is narrower than sweeping bandwidth.

(1) LEVEL mode



This displays only the measured value at each point.

Fig. 3-25 LEVEL mode

In this mode TRACE is L(R) and L(T) and 251 points of data sampled within the sweep frequency range are displayed on the screen. This is all shown in Fig. 3-25 which shows one frequency component in the sweep band and the selectivity characteristics of the intermediate frequency filter (BPF of Fig. 3-24).

Note

1. *If, in this mode, the difference between two adjoining frequencies becomes larger than the RBW setting, the frequency spectrum cannot be defected correctly. In such cases, use the SPECTRUM mode.*

2. *Only the specified frequency signal can be detected. This enables the MS560J to detect and display a only specified frequency spectrum in plural frequency spectrums.*

(2) SPECTRUM mode

In this mode TRACE is S(R) and S(T). It enables any spectrum between sampling points to be detected because the 1st local frequencies are swept by RBW/5 frequency step. At worst, a detection error of 0.2 dB may be produced in this mode.

Note

This mode is very useful in detecting an unknown signal. It does, however, take a long time to sweep.

3.2.2 Frequency Spectrum Measurements

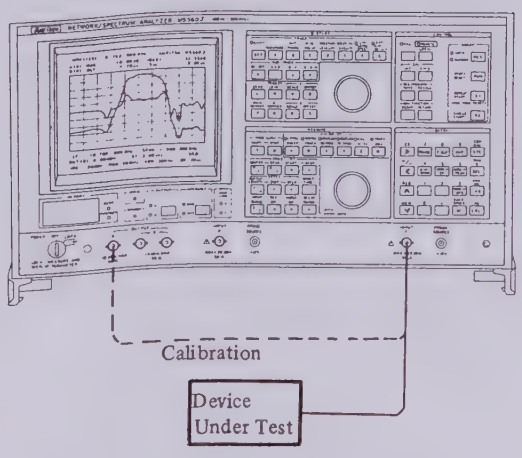


Fig. 3-26 Spectrum Analysis Connection

Measurement of frequency spectrum output from device under test can be done for a wide variety of signal waveforms and for a wide range of objects.

This paragraph explains the fundamental procedures for measuring frequency spectrums. Level, noise, frequency measurements, and video sweep operations are explained in other paragraphs.

Note

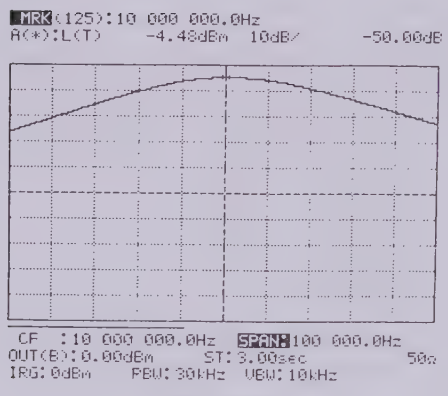
Refer to paragraphs 3.2.3, 3.2.4, 3.2.5, and 3.4 for details on level measurement, noise measurement, video sweep operation, and frequency measurement, respectively.

(1) Procedure

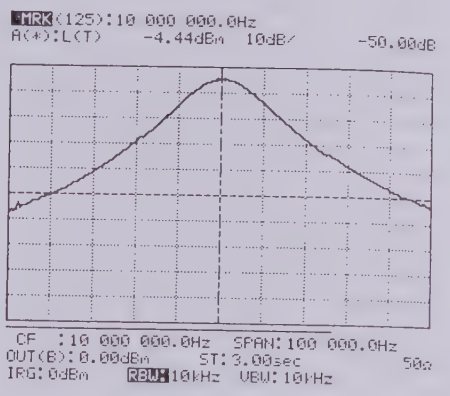
Step	Procedure
1	Turn the power ON
2	Confirm that the following items are set when the power is ON. · OUTPUT . . . . . B · IMPEDANCE . . . . . 50 Ω · LEVEL-OUTPUT . . . . . 0 dBm · LEVEL-SWEEP . . . . . OFF · COUPLED TO FREQ . . . . . OFF *Note* *After the power is ON, press the* [RECALL] *and* [9] *keys in that order to initialize the MS560J.*
3	Set TRACE to S(T).
4	Set the frequency.
5	Check the OVERLOAD lamp and set IRG as follows: When on: Increase IRG until the lamp goes out. When off: Decrease IRG as far as possible without turning the lamp ON.
6	Set RBW as indicated below. The adjusting procedure is explained in the next step.

Lowest frequency	RBW
≦100 Hz	3 Hz
≦300 Hz	3 Hz, 10 Hz
≦1 kHz	3 Hz to 30 Hz
≦3 kHz	3 Hz to 100 Hz
≦10 kHz	3 Hz to 300 Hz
≦30 kHz	3 Hz to 1 kHz
≦100 kHz	3 Hz to 3 kHz
≦300 kHz	3 Hz to 10 kHz
>300 kHz	3 Hz to 30 kHz

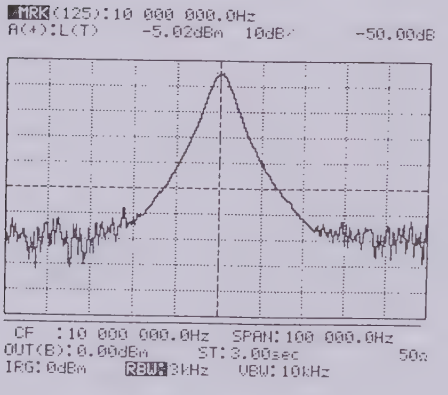
Step	Procedure
7	If RBW is varied from 30 KHz to 300 Hz when receiving a signal with CF: 1 MHz and SPAN: 100 KHz, the waveform shown in Fig. 3-27 is displayed on the screen. In this example, it is best to measure the frequency spectrum with RBW: 1 kHz.



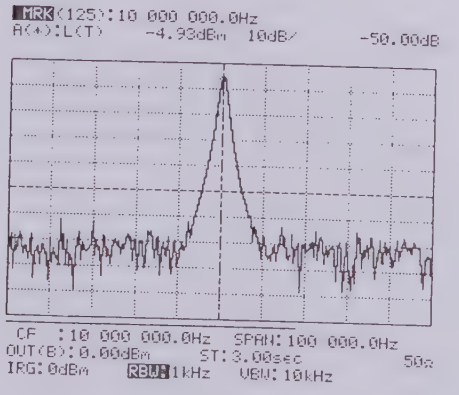
RBW 30 kHz



RBW 10 kHz



RBW 3 kHz



RBW 1 kHz

Fig. 3-27 RBW Adjustment

(2) Examples

(a) Distortion-measurement

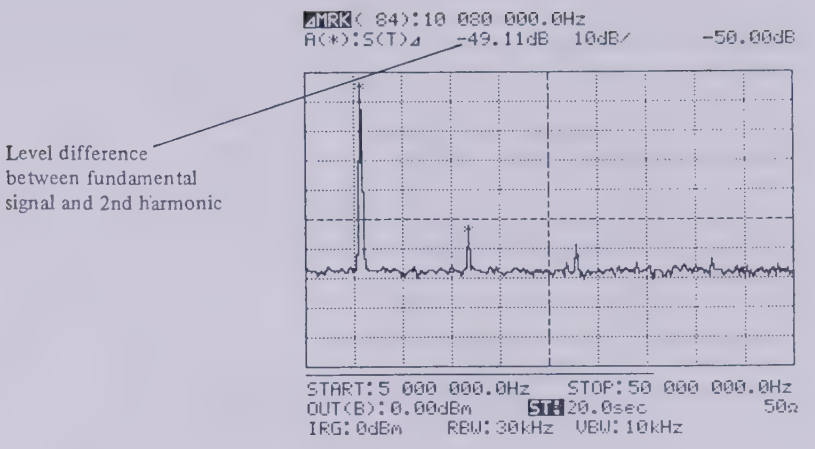


Fig. 3-28 Distortion Measurement

Figure 3-28 shows a waveform indicating a 1 MHz fundamental signal and its harmonics spectrum. When the sweep steps are greater (10 MHz/250) than the RBW (30 kHz) in this example, TRACE should be set in SPECTRUM mode.

A ratio of the fundamental signal and each harmonic can be obtained easily with the Δ marker. Since the frequency difference is also displayed at the same time, harmonic components and other components can be discriminated easily. Further, the total harmonic distortion (THD) can be obtained with the following formula:

$$THD = \frac{1}{A_1} \cdot \sqrt{A_2^2 + A_3^2 + A_4^2 + ... + A_n^2} \cdot 100\ (\%)$$

A_1 : Amplitude of fundamental signal

A_2, A_3 ... A_n : Amplitude of $_n$ order harmonics.

(b) Near spurious measurement

Figure 3-29 shows a spectrum waveform when a 1 MHz signal is measured with an RBW of 3 Hz. As can be seen in the figure, a signal 50 Hz away can be measured with more than 80 dB of the dynamic range. This is very helpful for spurious measurement of the power supply frequency component. In such measurements, the sweep time must be sufficiently long to read the results clearly.

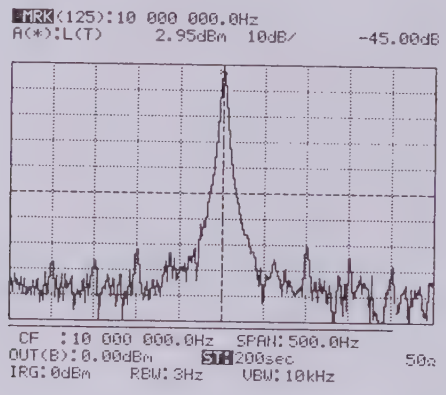


Fig. 3-29 Near Spurious Measurement

(c) Measurement of AM wave

Figure 3-30 shows a spectrum when a 1 MHz signal is AM-modulated with 1 kHz.

In this example, RBW is set to 100 Hz because a component 1 kHz away from the carrier wave need only be measured.

Because the spectrum at a point 2 kHz apart from the carrier wave is a harmonic component, the modulation distortion can be obtained from this level.

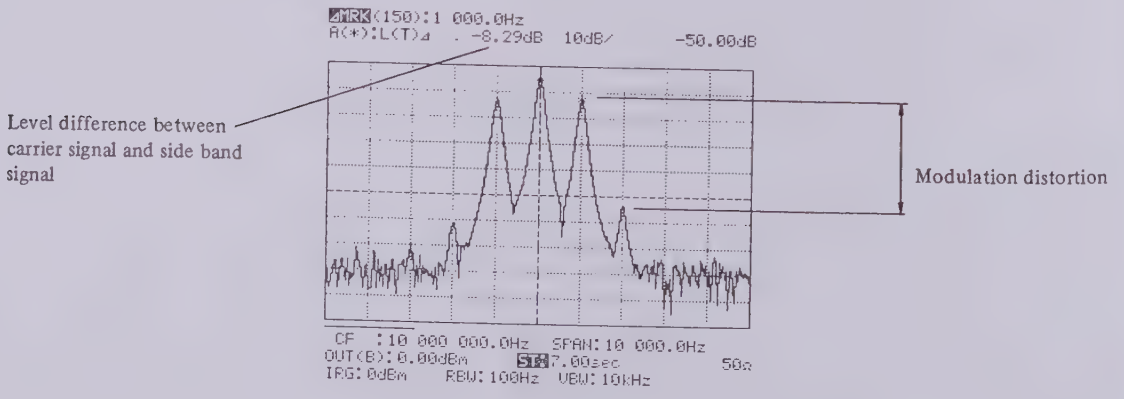


Fig. 3-30 AM Wave Measurement

3.2.3 Level Measurement

When the marker is set to the peak of the spectrum being measured, the level at the marker point is displayed digitally (Fig. 3-31).

When only an approximate input signal level is needed, this method is sufficient. To obtain a more exact level, however, the following procedures must be taken.

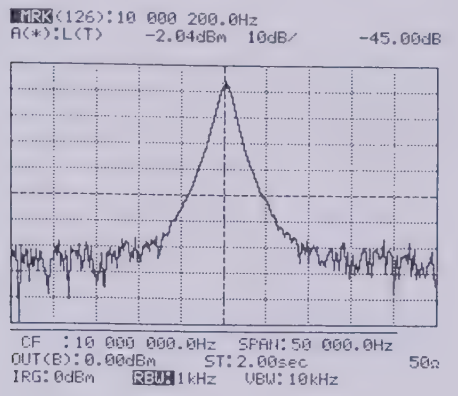


Fig. 3-31 Level Display

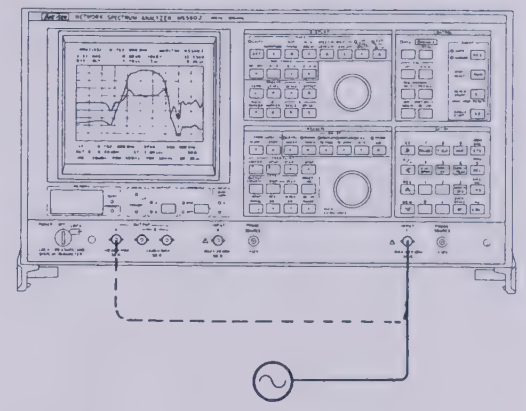


Fig. 3-32 Connections for Level Measurement

Step	Procedure
1	Turn the power on
2	Confirm that the following items are set when the power is ON. · OUTPUT ..... B · IMPEDANCE ..... 50 Ω · LEVEL-OUTPUT ..... 0 dB · LEVEL-SWEEP ..... OFF · COUPLED TO FREQ ..... OFF
	Note *After the power is ON, press the [RECALL] and [9] keys in that order to initialize the MS560J.*
3	Connect a signal to the input terminal (INPUT – T)
4	Set TRACE to L(T)
5	Turn the LIN lamp off.
6	Set the input signal frequency to CF.

Step	Procedure

7. Set SPAN, RBW, and ST as follows.

Frequency	SPAN	RBW	ST
≦ 100 Hz	50 Hz	3 Hz	150 sec
≧ 100 Hz	200 Hz	10 Hz	50 sec
≧ 300 Hz	500 Hz	30 Hz	10 sec
≧ 1 kHz	2 kHz	100 Hz	5 sec
≧ 3 kHz	5 kHz	300 Hz	1 sec
≧ 10 kHz	20 kHz	1 kHz	500 ms
≧ 30 kHz	50 kHz	3 kHz	500 ms
≧ 100 kHz	200 kHz	10 kHz	500 ms
≧ 300 kHz	500 kHz	30 kHz	500 ms

8 Check the OVERLOAD lamp.

When the lamp is on: Increase IRG until the lamp goes out.

When the lamp is off: Decrease IRG as far as possible without turning the lamp on.

9 Confirm the following setting.

OUTPUT: A
INPUT IMPEDANCE: 50 Ω

10 Turn on the FREQ COUNT mode with the ADV FUNCTION.

11 Set the measured frequency value to CF.

12 Connect OUTPUT–A to INPUT–T directly and press the [X → S] key.

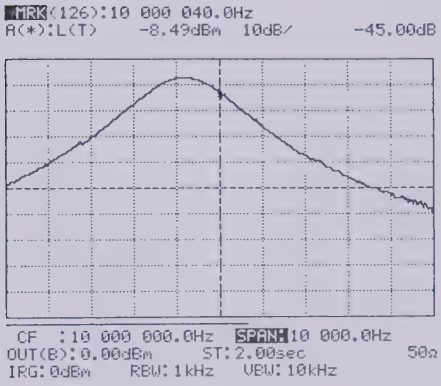
13 After one sweep measurement, connect a signal to the INPUT–T for measment.

14 Turn the X – S lamp ON.

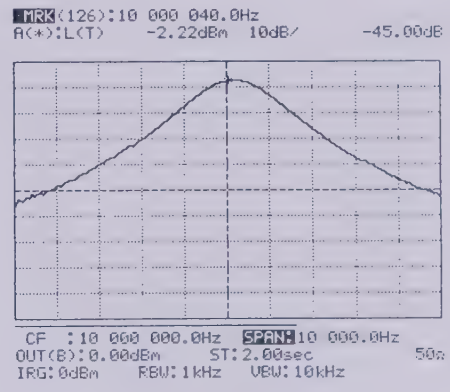
15 The value measured at this marker point indicates the exact signal level.

Note

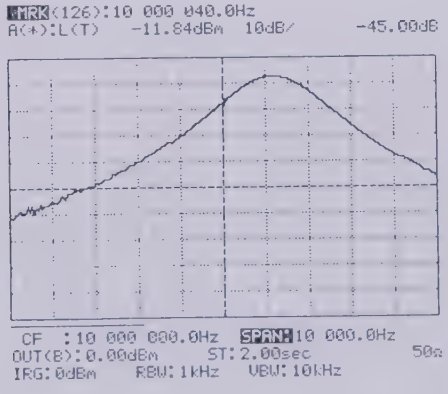
1. *One of the three screen displays shown in Figs. 3-33(a), (b) and (c) will appear.*
   (b) The level can be read by setting the marker at the top of the sepctrum without separation in steps 8 and 9.
   (a) and (c): A tracking error is indicated. Perform TRACK ADJ as explained in paragraph 2.8-(29). Repeat measurement steps 1 through 15.
2. *This method is used to get the frequency of an input signal to coincide with the calibration frequency.*
3. *This measurement is effective only when the frequency of the signal to be measured is stable.*
4. *When the measured signal frequency is unstable, measure the detuning error as explained in paragraph 3.2.4(1) and correct the top level of the spectrum by using this value.*



(a)



(b)



(c)

Fig. 3-33 Level Measurement

3.2.4 Noise Measurement

The MS560J can measure random noise levels, but because it uses a mean value detection, correction is required for rms value detection. To obtain the noise level per Hz, correct by setting RBW. The noise level per Hz is represented by the following formula.

$$N = L + B + 1 + \delta \quad (\mathrm{dBm} / \sqrt{\mathrm{Hz}}) \qquad (3.9)$$

- δ: Detuning error correction
- 1: Sensitivity correction of detected mean value
- B: RBW correction
- L: MS560J indication value

Table 3-2 RBW Correction
(to 1 Hz Bandwidth)

RBW	B
3 Hz	−5 dB
10	− 10
30	− 15
100	− 20
300	− 25
1 k	− 30
3 k	− 35
10 k	− 40
30 k	− 45

The actual noise level is obtained by measuring the δ and L and then calculating from the formula. The B value can taken from Table 3-2.

(1) How to measure the detuning error.

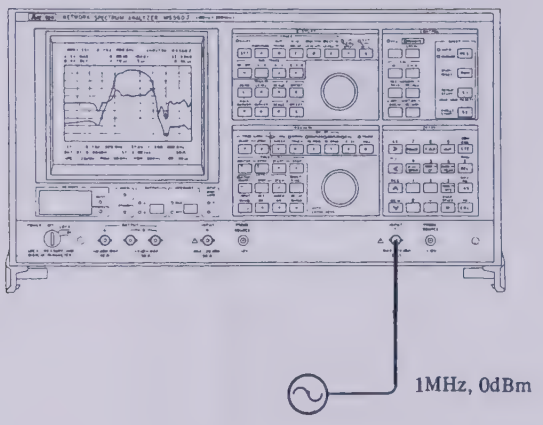


Fig. 3-34 Detuning error measurement connection

Step	Procedure
1	Turn the power ON
2	Confirm that the following items are set when the power is ON. • OUTPUT . . . . . B • IMPEDANCE . . . . . 50 Ω • LEVEL-OUTPUT . . . . . 0 dBm • LEVEL-SWEEP . . . . . OFF • COUPLED TO FREQ . . . . . OFF *Note* *After the power is ON, press the* [RECALL] *and* [9] *keys in that order to initialize the MS560J.*
3	Set TRACE to L(T)
4	Set CF to 1 MHz.

Step	Procedure

5 Set SPAN, RBW and ST as follows.

Frequency	SPAN	RBW	ST
≦100 Hz	10 Hz	3 Hz	100 sec
≧100 Hz	50 Hz	10 Hz	50 sec
≧300 Hz	100 Hz	30 Hz	10 sec
≧1 kHz	500 Hz	100 Hz	5 sec
≧3 kHz	1 kHz	300 Hz	1 sec
≧10 kHz	5 kHz	1 kHz	500 ms
≧30 kHz	10 kHz	3 kHz	500 ms
≧100 kHz	50 kHz	10 kHz	500 ms
≧300 kHz	100 kHz	30 kHz	500 ms

6 Set IRG to 0 dBm

7 Set the A–SCALE OFFSET as follows:
SCALE – 0.5 dB
OFFSET – 0.00 dB

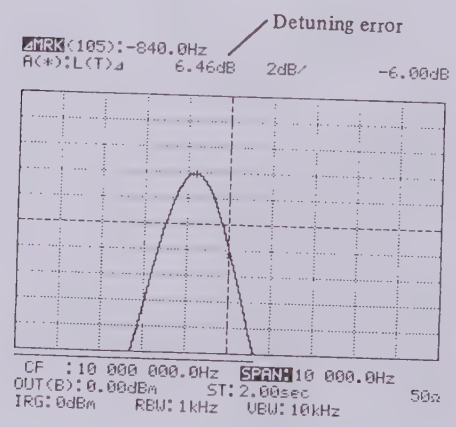


Fig. 3-35 Detuning Error

8 When the Δ marker is set as shown in Fig. 3-35, the digital display indicates a detuning error.

Note

Use a 1 MHz signal source with excellent frequency stability and accuracy.

(2) Noise measurement

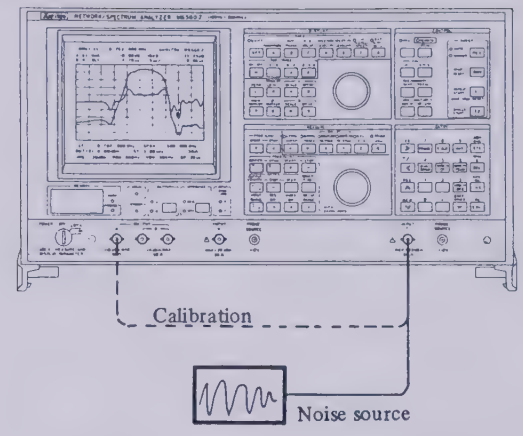


Fig. 3-36 Noise Measurement Connection

Step	Procedure
1	Turn the power ON.
2	Confirm that the following items are set when the power is ON. • OUTPUT . . . . . B • IMPEDANCE . . . . . 50 Ω • LEVEL-OUTPUT . . . . . 0 dBm • LEVEL-SWEEP . . . . . OFF • COUPLED TO FREQ . . . . . OFF *Note* *After the power is ON, press the* [RECALL] *and* [9] *keys in that order to initialize the MS560J.*
3	Set TRACE to L(T).
4	Set the frequency range.
5	Set the following items. • OUTPUT . . . . . A

Step	Procedure

6 Set RBW as indicated below.

Frequency	RBW
≦ 100 Hz	3 Hz
≧ 100 Hz	3 Hz, 10 Hz
≧ 300 Hz	3 Hz to 30 Hz
≧ 1 kHz	3 Hz to 100 Hz
≧ 3 kHz	3 Hz to 300 Hz
≧ 10 kHz	3 Hz to 1 kHz
≧ 30 kHz	3 Hz to 3 kHz
≧ 100 kHz	3 Hz to 10 kHz
≧ 300 kHz	3 Hz to 30 kHz

7 Connect a signal to be measured to INPUT–T for measurement.

8 Set ST so that the UNCAL lamp is off.

9 Check the OVERLOAD lamp and set IRG as follows:
When the lamp is ON: Increase IRG until the lamp goes out.
When OFF: Decrease IRG as far as possible without turning the lamp ON.

10 Connect OUTPUT–A and INPUT–T directly and press the [X → S] key.

11 After one sweep measurement turn the X – S lamp on and connect the signal to be measured.

12 Calculate the noise level per Hz, using the displayed L(T) value for L in the formula 3.9.

Note

For the noise measurements make sure that the noise of the MS560J is smaller than that of the signal to be measured. This is confirmed checking to see whe For the noise measurement make sure that the noise of the MS560J is smaller than that of the signal to be measured. This is confirmed checking to see whether the measured value decreases when the input signal removed.

3.2.5 Linear Display and Video Sweep

(1) Linear display

When TRACE is L(R), L(T), S(R) and S(T), the vertical axis can be displayed linearly (logarithmic in normal cases). Examples of logarithmic and linear displays are given below.

Note

The video sweep mode is established when the frequency width is 0 Hz and the LIN lamp is on. See item (2) in this paragraph for the procedures to follow at this point.

(a) Logarithmic display / Linear display

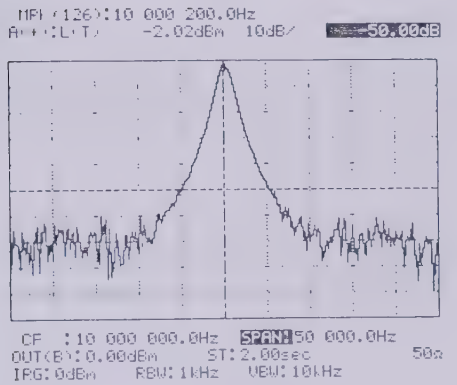


Fig. 3-37 Logarithmic Display

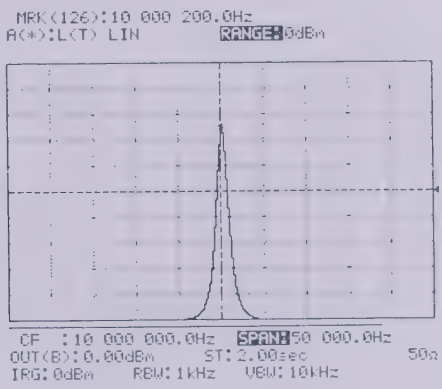


Fig. 3-38 Linear Display

Figure 3-37 shows a logarithmic display when measuring a signal in L(R), L(T), S(R) or S(T).

Figure 3-38 shows the waveform displayed on the screen when the LIN lamp is turned on under the same conditions as given above.

(b) Linear expansion display

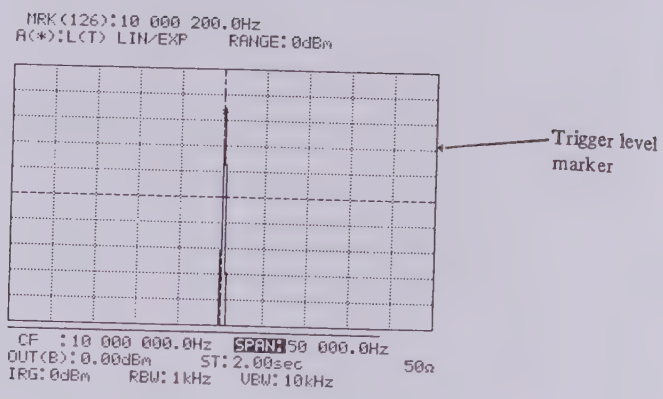


Fig. 3-39 Linear Expanded Display

Figure 3-39 show the waveform displayed on the screen when the EXP lamp is turned ON under the same measuring conditions as given in Fig. 3-37. In this figure, the waveform is expanded 10 times around the trigger level marker shown in Fig. 3-38.

(c) Adjusting and reading the linear display

The size of a waveform displayed linearly can be switched by 10 dB steps using A-OFFSET or IRG. A-OFFSET adjusts the IF range. The range display on the screen is the sum of the above two and indicates the top line of the screen.

Fig. 3-40 shows how to read the RANGE.

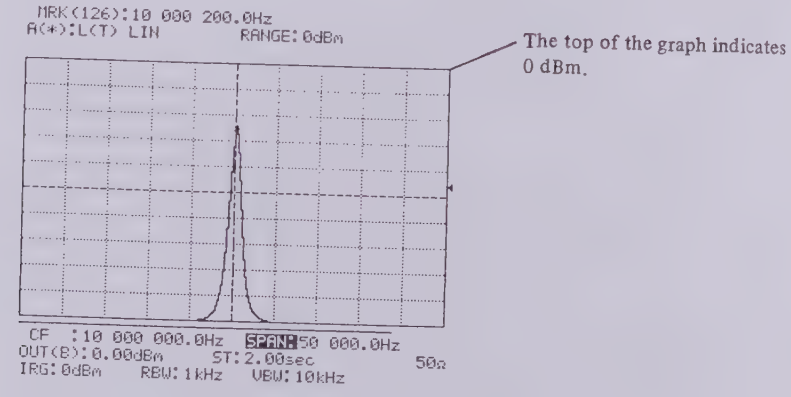
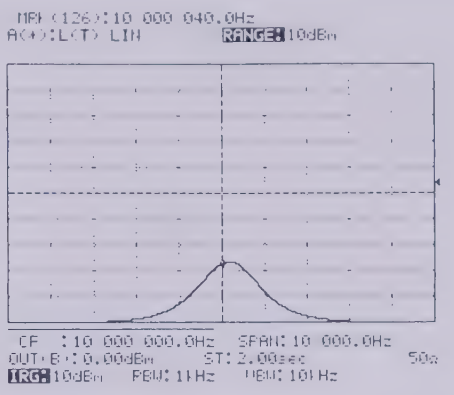


Fig. 3-40 How to Read the Linear Display

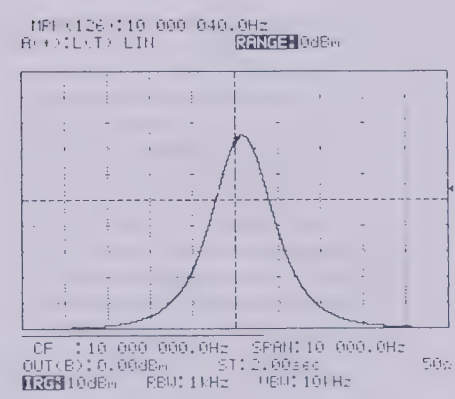
Figure 3-41 (a) to (c) shows the display waveform on the screen when the range is switched.

RANGE: 10 dBm



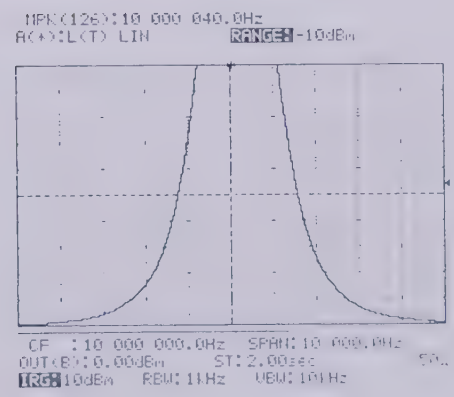
(a)

RANGE: 0 dBm



(b)

RANGE: −10 dBm



(c)

Fig. 3-41 Linear Display

(2) Video Sweep Operation

Video sweep is used to display the envelope of an input signal on the screen. The principal specifications are as follows:

- Carrier frequency: 100 Hz to 300 MHz
- Modulation frequency: 1 Hz to 200 Hz
- Sweep mode: REPEAT
  SINGLE
- Trigger system: Internal trigger
- Trigger level: Can be displayed on the screen and adjusted with the tuning knob.

Note

The highest modulation frequency is limited by RBW and VBW.

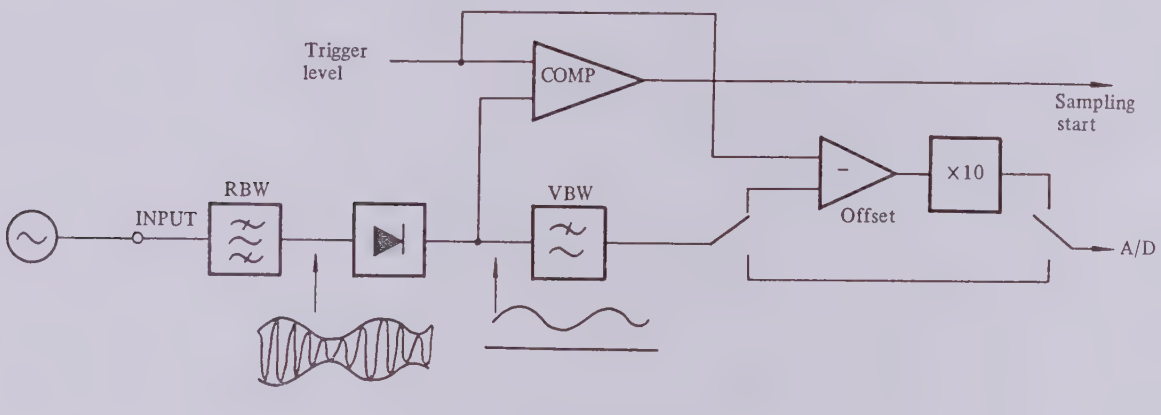


Fig. 3-42 Principle of video sweep operation

The principle of video sweep operation is shown in Fig. 3-42. An input signal detected at the linear detector is digitalized in a definite cycle by the A/D converter.

This digitalized data can be regenerated as an envelope of the input signal on the screen. The trigger level can be set to any level of the detector output and a sampling start signal is generated at the crossing point of the detector output. This trigger level becomes an offset in EXPAND mode. This means that the signal display is expanded 10 times around the trigger level when in EXPAND mode.

Note

The video sweep operation has a definite cycle of sampling, but the sampling cycle when displaying linearly is not definite because it interlocks with the frequency sweep operation.

(1) Procedures

Step	Procedure
1	Turn the power ON
2	Confirm that the following items are set when the power is ON. • OUTPUT . . . . . B • IMPEDANCE . . . . . 50 Ω • LEVEL OUTPUT . . . . . 0 dB • LEVEL SWEEP . . . . . OFF • COUPLED TO FREQ . . . . . OFF *Note* *After the power is ON, press the [RECALL] and [9] keys in that order to initialize the MS560J.*
3	Set TRACE to L(T).
4	Set CF to the carrier frequency of the input signal.
5	Set SPAN to 5 Hz.
6	Set RBW as indicated below.

Lowest frequency	RBW
≦100 Hz	3 Hz
≦300 Hz	3 Hz, 10 Hz
≦1 kHz	3 Hz to 30 Hz
≦3 kHz	3 Hz to 100 Hz
≦10 kHz	3 Hz to 300 Hz
≦30 kHz	3 Hz to 1 kHz
≦100 kHz	3 Hz to 3 kHz
≦300 kHz	3 Hz to 10 kHz
>300 kHz	3 Hz to 30 kHz

7	Set VBW to 10 kHz.

Step	Procedure
8	Check the OVERLOAD lamp. • When the lamp is ON: Increase IRG until the lamp goes out. • When the lamp is OFF: Decrease IRG as far as possible without turning the lamp ON.
9	Turn the LIN lamp ON.
10	Adjust A-OFFSET so that the input signal is displayed within the scale. (Fig. 3-43)
11	Adjust the trigger level marker as shown in Fig. 3-44.
12	The MS560J is ready for video sweep operation when SPAN is set to 0 Hz. (Fig. 3-45)
13	Adjust ST so the waveform is easy to read. (Fig. 3-46)

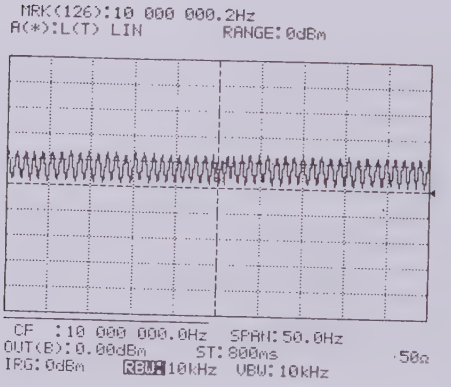


Fig. 3-43 Video Sweep (A)

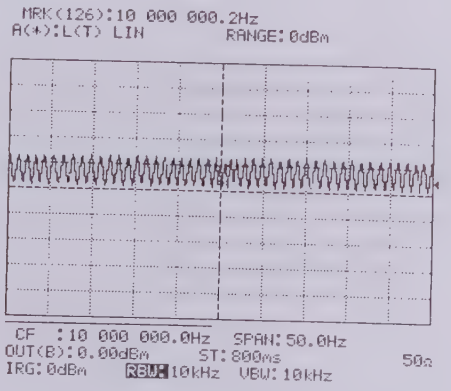


Fig. 3-44 Video Sweep (B)

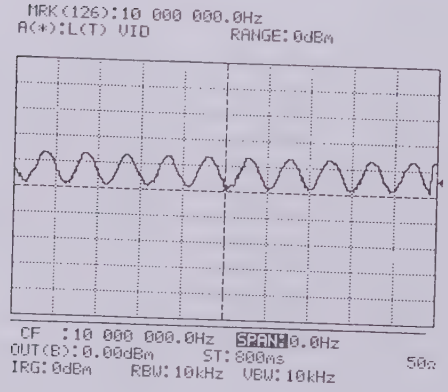


Fig. 3-45 Video Sweep (C)

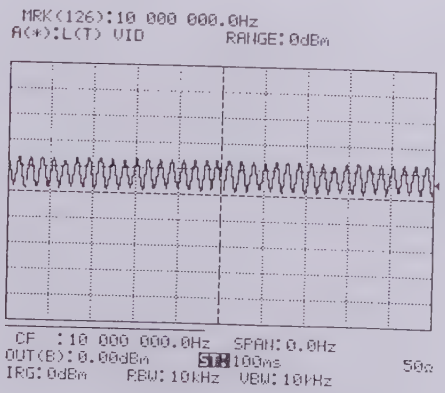


Fig. 3-46 Video Sweep (D)

3.3 SYNTHESIZER

The MS560J has a built-in synthesizer as its signal source. This synthesizer can be used as a tracking generator for measuring transmission characteristics, a calibration signal source for level measurements, and as an independent synthesizer. This paragraph explains how to use the MS560J as an independent synthesizer and how to carry out a level sweep operation.

(1) Synthesizer

When using the MS560J as an independent synthesizer, set the frequency and level as explained below.

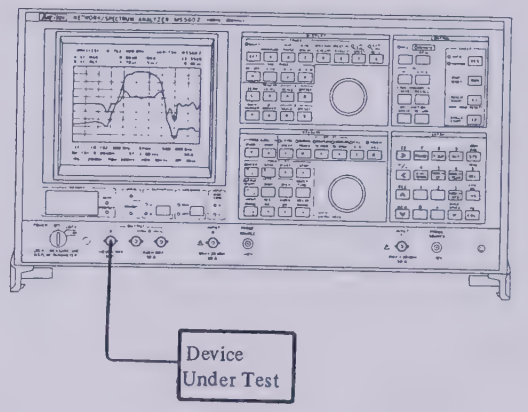


Fig. 3-47 Synthesizer

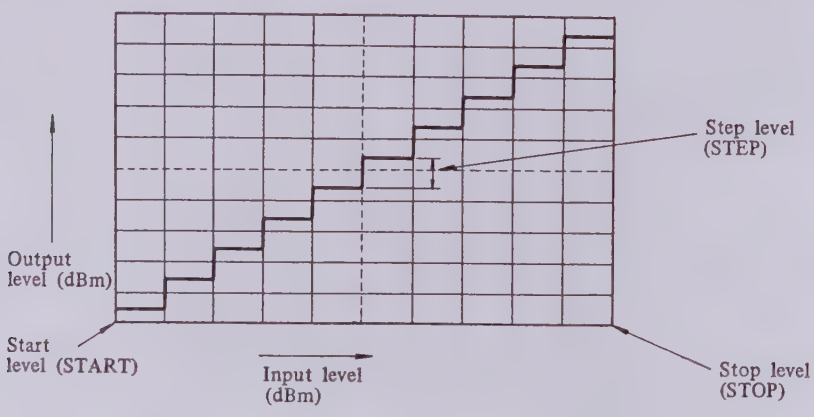
Step	Procedure
1	Set the OUTPUT to A
2	Set the MAIN marker to center (125)
3	Set the AUTO/MARKER to MARKER.
4	Press the [REPEAT START] key.
5	Set the output frequency to CF.
6	Press the [OUTPUT (START)] key and set the output level.

Note

1. *The MS560J should not be used as the sweep signal source without interlocking it with its receiving section.*
2. *The frequency and level can be output by repeating steps 5 and 6 above.*

(2) Level sweep

The MS560J can sweep a signal level while the frequency is kept constant or sweep both the level and frequency at the same time. The first procedure is used to test level characteristics and the second is used when the equalizer amplifier is to be measured at a constant output level. In both cases, the level is swept as explained below.



$$\cdot\ m = \frac{STOP - START}{STEP.}$$

START, STOP; $-$ 110.00 $\sim$ + 15.00 dBm

STEP: 0 $\sim$ 125 dB

m: Indicates the number of level switching steps over the full sweep range which is carried from the decimal point position.

The level is switched at each $\frac{250}{m-1}$ (truncated below the decimal point).

Level L (n) of step n is,

$$L(n) = START + n \cdot STEP$$

n: 0, 1, 2, ... , m $-$ 1

$$L(m) = STOP$$

Fig. 3-48 Level Sweep

3.4 SUB TRACE

SUB TRACE can be used for one item measurement(TRACE other than M/P and M/D). SUB TRACE has the following three functions:

(1) A → B

(a) When this key is pressed, the latest contents of memory A are copied and stored into memory B.

(b) SCALE and OFFSET have the same values as channel A.

(c) The waveform can be adjusted with B-SCALE and OFFSET.

(d) The contents of memory B can be backed-up at the PBM. See paragraph 2.8–(40).

(e) This function is used as a preparatory operation when using the A – B function of item (3) and also used as described below.

Fig. 3-49 shows simultaneous display of two measured waveforms of filter. This is convenient when matching a filter characteristic to the reference filter characteristic, or when finding the correlation between two filters having a different center frequency.

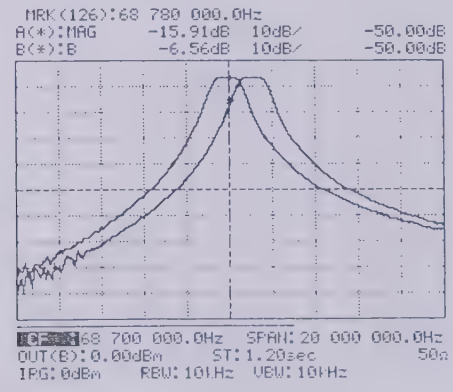


Fig. 3-49 Display Example (A → B)

(2) B = A

(a) After this key is pressed, the measured value is stored in both memory A and memory B.

(b) SCALE and OFFSET are the same value as channel A.

(c) The waveform can be adjusted with B-SCALE and OFFSET'

(d) This function is convenient when desirting to observe the entire characteristic and the pass-band ripple of a bandpass filter simultaneously.

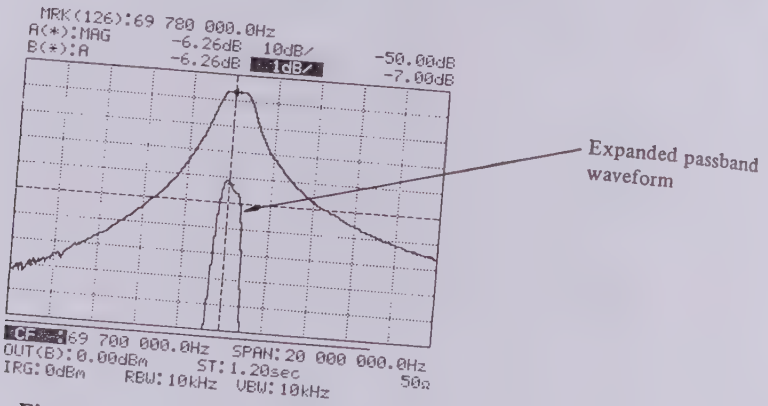


Fig. 3-50 Display Example (B = A)

(3) B = A − B

(a) After this key is pressed, the difference between the channel A measured value and the contents of memory B is displayed at channel B.

(b) SCALE and OFFSET are the same as channel A.

(c) The waveform can be adjusted with B-SCALE and OFFSET.

(d) This function is convenient when comparing the measured values of two devices under test.

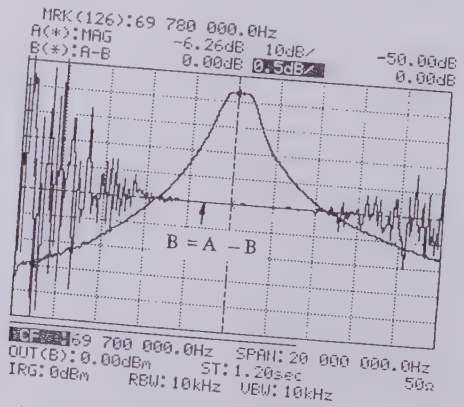


Fig. 3-51 Display Example (B = A−B)

3.5 AUTOSETTING

(1) SIGNAL TRACK

When this lamp is on and the frequency sweep is linear, the frequency for each sweep is automatically set so the peak value of the received signal is at the center. Fig. 3-52 shows an example.

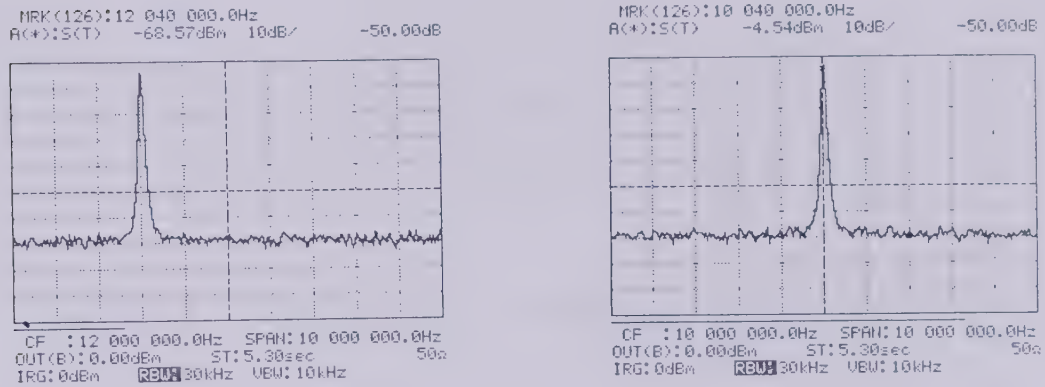


Fig. 3-52 SIGNAL TRACK

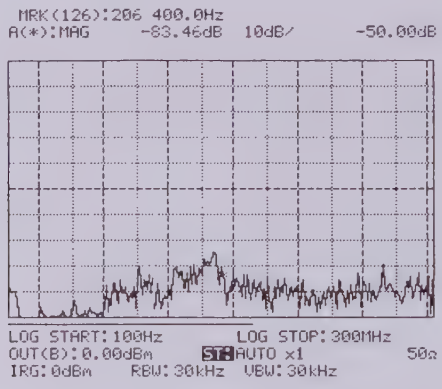
(2) COUPLED TO FREQ.

When this lamp is on, RBW and ST are automatically set according to the measurement frequency.

Note

1. *This function is must effective during logarithmic sweep. Do not use it during linear sweep because the RBW will not be change continuously and is unstable.*
2. *ST can be variable. Use it to match the response time of the device under test during circuit analysis. .*

Fig. 3-53 shows an example. The connection is the same as Fig. 3-3.



RBW changes with the scale line frequency.

Fig. 3-53 COUPLED TO FREQ

(3) COUPLED TO SPAN

When this lamp is on, RBW, VBW, and ST are automatically set according to the scan width.

3.6 ADV FUNCTION

3.6.1 Integrating

The following methods are used to stabilize the values measured with the MS560J that is to lower the noise level.

(a) Narrow RBW

Noise level decreases in comparison with band width. See Fig. 3-54.

(b) Narrow VBW

The mean value of noise is constant, but scattering can be reduced. See Fig. 3-55.

(c) Integration

By turning on INTEGRATING of ADV FUNCTION, the measured value at one point is integrated, for time shown in the table below. See Fig. 3-56.

RBW	Integrating time
100 Hz to 30 kHz	20 ms / 16.7 ms *
30 Hz	33 ms
10 Hz	100 ms
3 Hz	333 ms

* Can be switched according to ac power supply frequency.

Measuring examples are shown below.

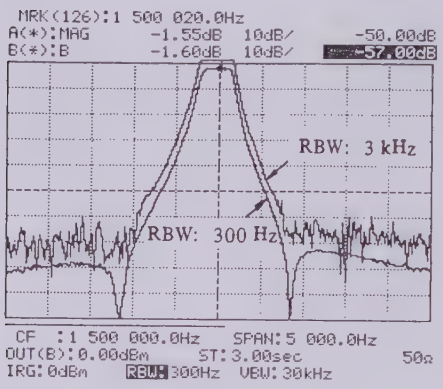


Fig. 3-54 Effect of RBW

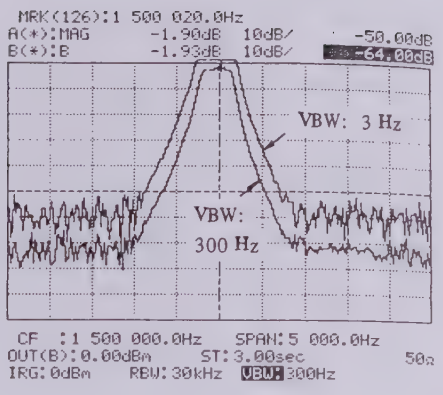


Fig. 3-55 Effect of VBW

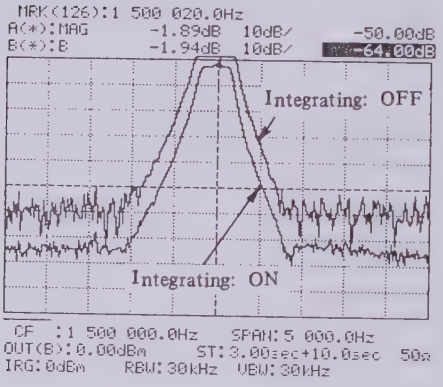
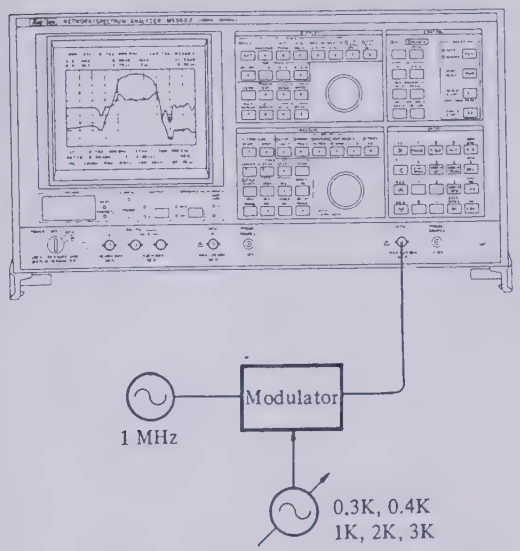
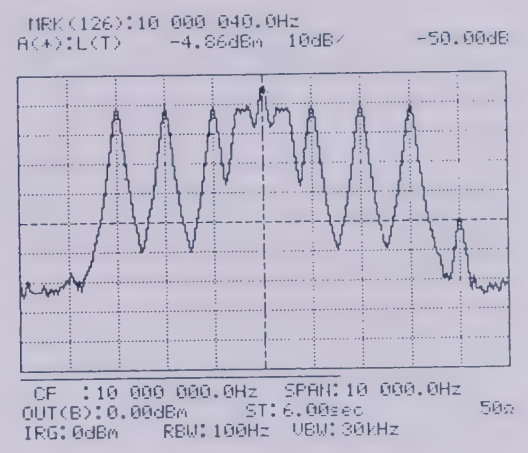


Fig. 3-56 Effect of integrating

3.6.2 MAX HOLD

If MAX HOLD is turned on when TRACE is L(R), L(T), S(R), or S(T), the maximum value at each point for each sweep is held as the measured value. This measured value is cleared by pressing the [REPEAT START] key. The following is an example of measuring using this function.





Dotted data shows a response of modulation frequency.

Fig. 3-57 Measurement of modulation frequency response

3.6.3 Frequency count

When the frequency count mode is turned on by ADV FUNCTION, the MS560J can be used as a frequency counter with 1 Hz resolution. Since the MS560J is a tuning-type receiver, it can measure the frequencies of low-level signals. Further, it can measure the specified frequency spectrums of signals having more than one spectrum.

(1) Principle of operation

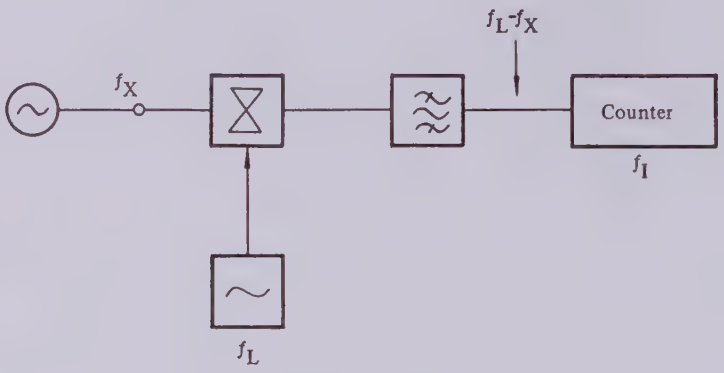


Fig. 3-58 Frequency count

Figure 3-58 shows the operation principle of a frequency counter. Using the count value f_I (gate time is 1 sec.) of the digital counter in the digital counter in the figure, fx is obtained from the following formula.
la.

$$fx = f_L - f_I$$

fx can be calculated in the above formula, because f_L is a set value of a local synthesizer.

(2) Procedure

Step	Procedure
1	Turn the power ON.
2	Confirm that the following items are set when the power is ON. • OUTPUT . . . . . B • IMPEDANCE . . . . . 50 Ω • LEVEL-OUTPUT . . . . . 0 dBm • LEVEL– SWEEP . . . . . OFF • COUPLED TO FREQ . . . . . OFF *Note* *After the power is ON, pressing the [RECALL] and [9] keys in that order to initialize the MS560J.*
3	Set TRACE to L (R), L (T), S (R) or S (T).
4	Set the sweep frequency range.
5	Set RBW as indicated below.

Lowest frequency	RBW
≦100 Hz	3 Hz
≦300 Hz	3 Hz, 10 Hz
≦1 Hz	3 Hz to 30 Hz
≦3 kHz	3 Hz to 100 Hz
≦10 kHz	3 Hz to 300 Hz
≦30 kHz	3 Hz to 1 kHz
≦100 kHz	3 Hz to 3 kHz
≦300 kHz	3 Hz to 10 kHz
>300 kHz	3 Hz to 30 kHz

Step	Procedure
6	Adjust IRG so that the OVERLOAD lamp if OFF.
7	Adjust ST so that the UNCAL lamp is OFF.
8.	Press the [BEGIN] key of ADV FUNCTION.
9	Press the [/] [4] and [EOL] keys in that order.
10.	Press the [O] [N] and [EOL] keys in that order.
11	Press the [RETURN] key.
12	When the MAIN marker is set to the spectrum measured, the frequency of the spectrum is measured and displayed at every sweep.

Note

If AUTO/MARKER is set to MARKER, measurement repetition rate will be greater.

3.6.4 Frequency Offset Tracking

By connecting the MS560J with the MG443B, MG440A or MG545[ ]. Frequency Synthesizer through the GP–IB, they can be tracked by shifting their frequency. This function and the excellent flatness of the MG443B, MG440A and MG545[ ] output levels make it possible to accurately measure the magnitude characteristics of a misxer or a circuit including a mixer.

(1) Connection

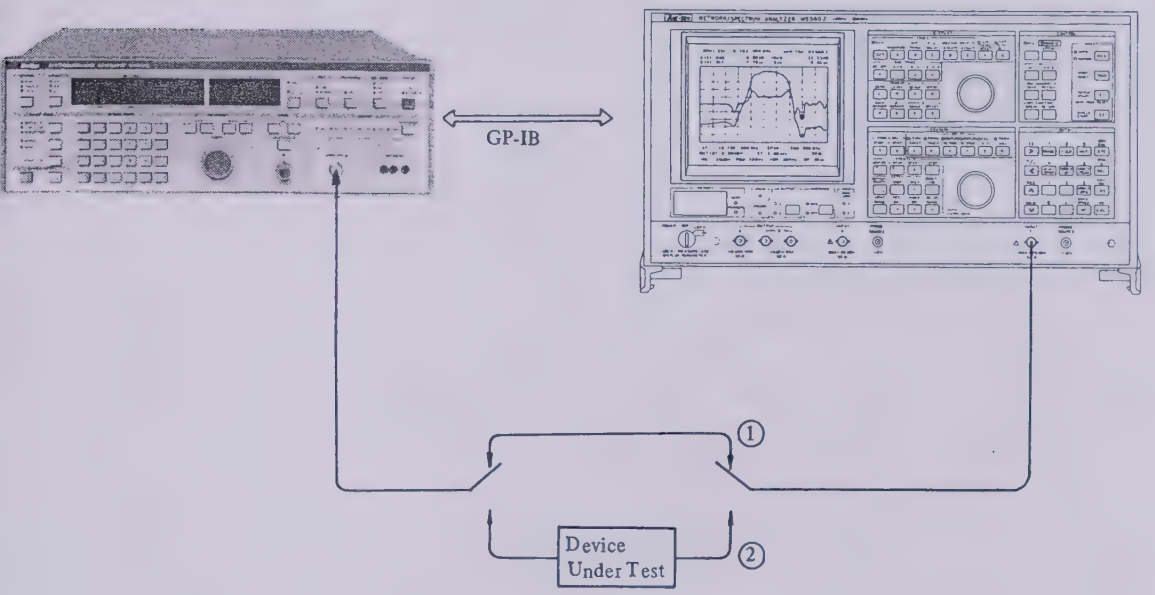


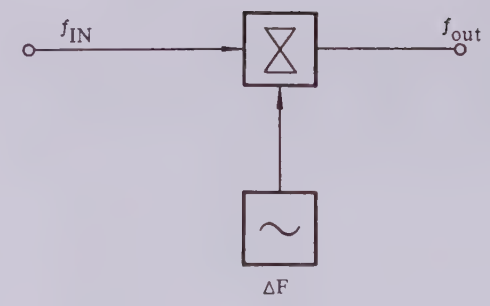
Fig. 3-59 Connections

(2) Frequency Conversion System

With the frequency conversion system, any one of the three modes shown in Fig. 3-60 can be selected.

(3) Measuring accuracy

The accuracy of this measurement is determined by the flatness of the Frequency Synthesizer output level and linearity of level measurement with the MS560J. The output level accuracy of each Frequency Synthesizer is given in Table 3-5.



MODE	Conversion system
0	$f$out : f_{IN} + ΔF • $f$out ≦ 300 MHz
1	$f$out : f_{IN} − ΔF • f_{IN} > ΔF • $f$out ≦ 300 MHz • f_{IN} : 10 Hz ~ 500 MHz
2	$f$out : ΔF − f_{IN} • ΔF > f_{IN} • $f$out ≦ 300 MHz • f_{IN} : 10 Hz ~ 500 MHz

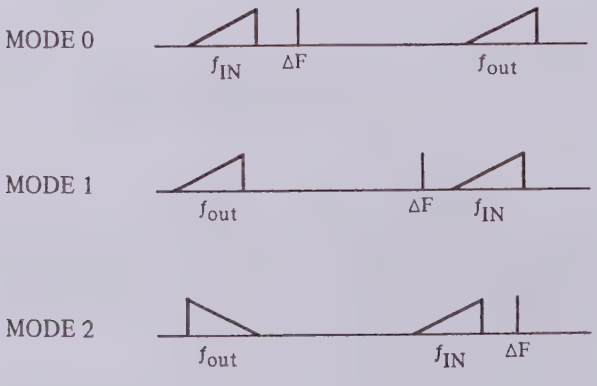


Fig. 3-60 Frequency Conversion System

Table 3-5 Synthesizer Output Level Accuracy

Level	MG443B	MG440A	MG545A
+ 15 dBm + 10	10Hz ±0.2 7MHz ±0.3 13MHz 30MHz ±0.4	10 Hz ~ 100 Hz ± 0.3	
+ 5 – 0 – 5 – 10 – 15 – 20	10 Hz 7 MHz 30 MHz ± 0.15 ± 0.2	100 Hz ~ 1 MHz ± 0.2 1 ~ 10 MHz ± 0.3 10 ~ 30 MHz ± 0.4	100 kHz ~ 100 MHz ±0.25 10 kHz ~ 500 MHz ±0.6
– 25 – 30 – 35 – 40 – 50		10 Hz ~ 100 Hz ± 0.4 100 Hz ~ 1 MHz ± 0.3 1 MHz ~ 10 MHz ± 0.4 10 MHz ~ 30 MHz ± 0.5	
– 55 – 60 ⟨ – 80	10 Hz 7 MHz 30 MHz ± 0.2 ±0.3	± 0.6	

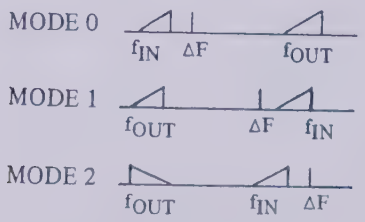
(4) Procedure

Step	Procedure
1	Turn on the power. (MS560J is initialized by pressing the [RECALL] and [9] keys)
2	Set the following items. • TRACE : L (T) • INPUT IMPEDANCE : * • FREQUENCY : Set the device under test output frequency • RES BW : * • VIDEO BW : * (*: Set these values according to the specified measurement conditions of the device under test)
3	Set the SYNTHESIZER according to the specified measurement conditions of the device under test exclusive of the frequency. Set the MG443B STEP FREQ to (MS560J SPAN)/250, when the SYNTHESIZER FORMAT F is used.
4	Set the sweep time so that the UNCAL lamp does not light.
5	Press the [BEGIN] key.
6	Press the [/] [1] [0] and [EOL] keys.
7	Press the [A] [D] [R] [C] and [EOL] keys.
8	Press the [/] [1] [1] and [EOL] keys.
9	Press the [#] [0] [,] [A] and [EOL] keys. SYNTHESIZER FORMAT SYNTHESIZER GP-IB ADDRESS

SYNTHESIZER FORMAT

A : MG440A/K
MG545A/K
MG443B only mode
B : MG440C/M
MG545C/M
C : Wavetek 178
D : MG443B
E : HP3336
F : MG443B High speed

Step	Procedure
10.	Press the [/] [4] and [EOL] keys, and then the [0] and [EOL] keys.
11.	Press the [RETURN] key.
12.	Connect the synthesizer output connector to the MS560J INPUT connector directly through a circuit or with a cable instead of the device under test.
13.	Set the IRG so that the OVERLOAD lamp does not light.
14.	Set the sweep time to obtain the appropriate measured data display on the screen.
15.	Press the [CAL X→S] key, and wait for completion of one sweep measurement.
16.	Connect the device under test.
17.	Press the [BEGIN] key.
18.	Press the [/] [5] and [EOL] keys.
19.	Set the TRACKING MODE referring to the following figure.



20.	Press the [/] [4] and [EOL] keys, and then set the ΔF.
21.	Press the [RETURN] key.
22.	Confirm that the OVERLOAD lamp does not light.
23.	Read the measured value on the screen using the marker.

* To release the tracking, proceed as follows:

Step	Procedure
1	Press the [BEGIN] key.
2	Press the [/], [1], [1] and [EOL] keys in that order.
3	Press the [EOL] key.

* When changing the output level of the MG443B, do the following:

Step	Procedure
1	Set the AUTO/MARKER key of the MS560J to MARKER.
2	Press the [LOCAL] key of the MG443B.
3	Set the output level.
4.	Set the AUTO/MARKER of the MS560J to AUTO.

3.6.5 Tracking

One MS560J can be used as the signal source and another MS560J can be connected to it as the receiver. This is convenient when measuring the transmission characteristic between two FDM repeater stations, etc.

(1) Connection

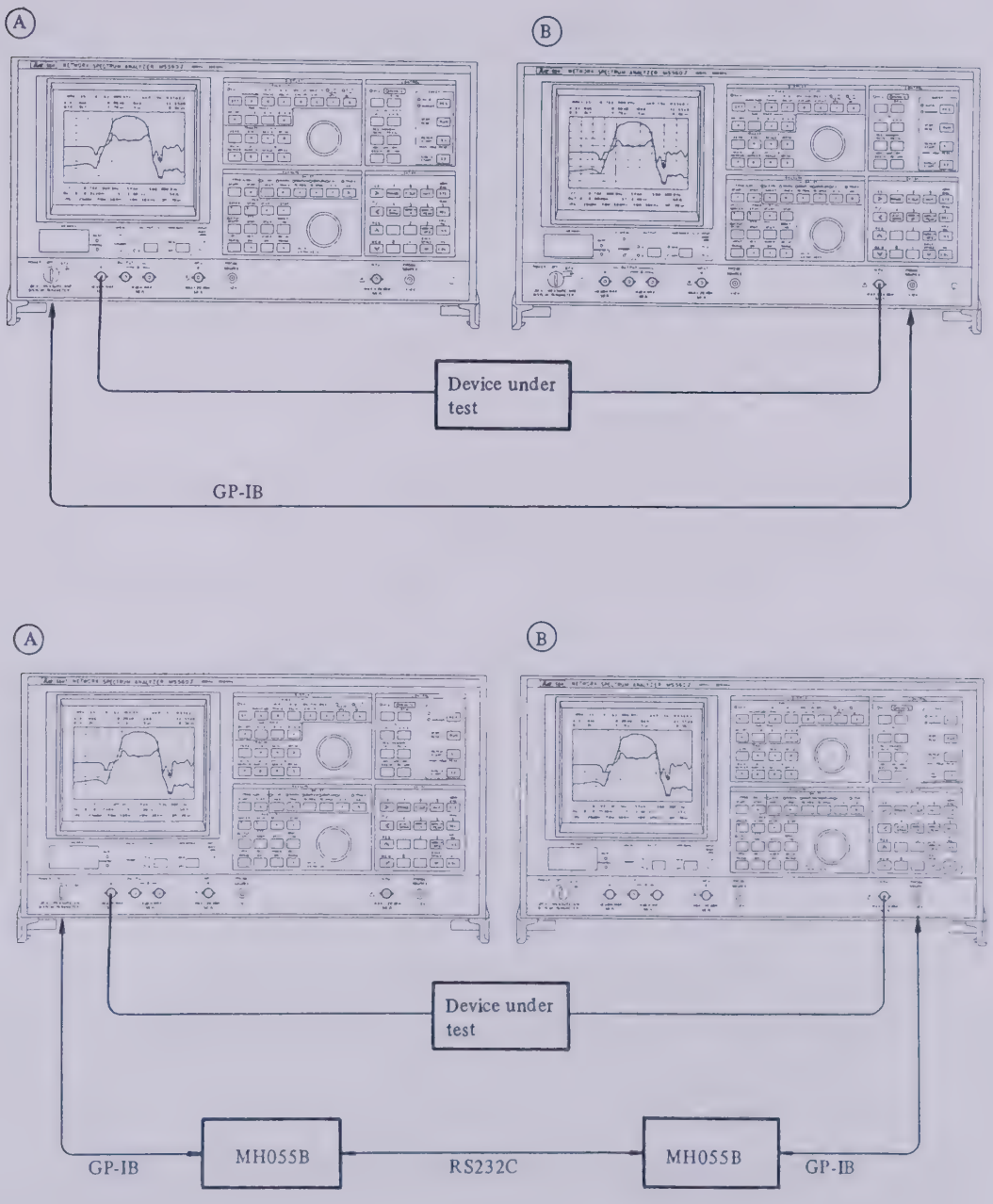
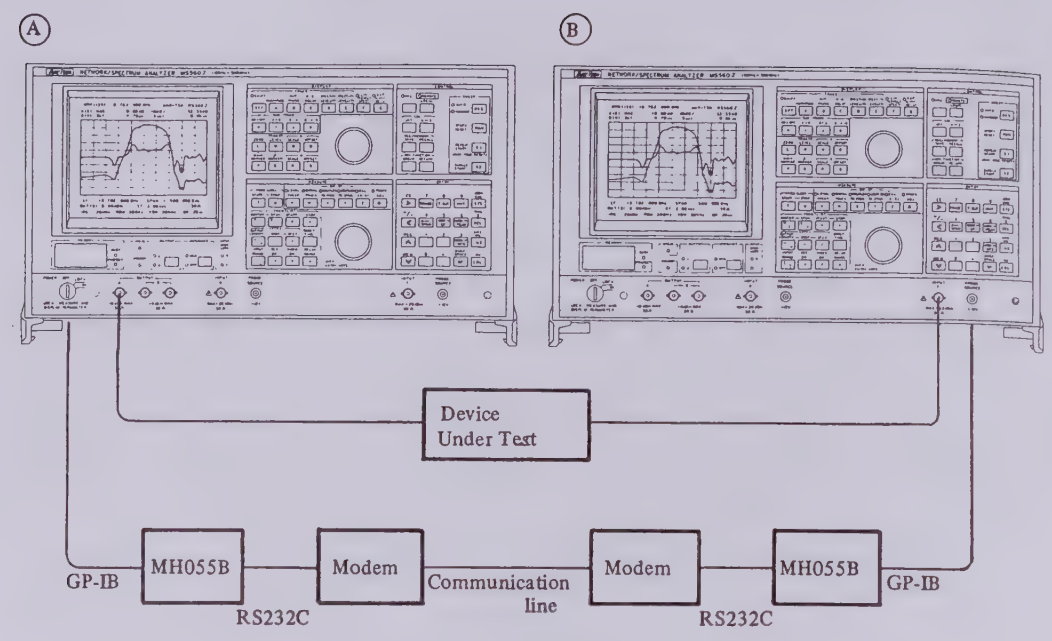


Fig. 3-61 Connection



A: Signal source
B: Receiver
MH055B: GP-IB extender

Fig. 3-61 Connection (Cont'd)

(2) Procedure

Step	Procedure
1	Interconnect two MS560J as shown in Fig. 3-61, and set MS560J – (A) GP–IB address 1.
2	Set the power switch of MS560J – (A) (signal source) to ON.
3	Set the power switch of MS560J – (B) (receiver) to ON.
4	Set the MS560J – (A) as follows • OUTPUT . . . . . A • LEVEL . . . . . * • Sweep frequency . . . . . * • LEVEL SWEEP . . . . . OFF Set * according to the measurement specifications.

Step	Procedure
5	Set MS560J – (B) as follows: • TRACE . . . . . L(T) • INPUT IMPEDANCE . . . . . 50Ω • OUTPUT . . . . . A • VBW . . . . . 30 kHz Operation of MS560J – (B) is described below.
	Note *See paragraph 3.6.1–(b) for the VBW.*
6	Press the [BEGIN] key.
7	Press the [/] [1] [0] [EOL] keys in this order.
8	Press the [A] [D] [R] [C] [EOL] keys in this order.
9	Press the [/] [1] [1] [EOL] keys in this order.
10	Press the [#] [1] [,] ["] [F] [M] [1] ["] [EOL] keys in this order
11	Press the [/] [1] [0] [EOL] keys in this order.
12	Press the [F] [A] [R] [1] [EOL] keys in this order
	Note *After this operation, the two MS560J are tracked by frequency. To release this tracking, press the [F] [A] [R] [0] [EOL] keys in this order.*
13	Press the [RETURN] key.
14	Check the OVER LOAD lamp, and set IRG as follows: Lamp ON: Increase IRG until the lamps turns OFF. Lamp OFF: Decrease IRG as far as possible without turning the lamp ON.

Step	Procedure

15 Set the RBW according to the following conditions:

Lowest frequency	RBW
≦ 100 Hz	3 Hz
≦ 300 Hz	3 Hz, 10 Hz
≦ 1 kHz	3 Hz to 30 Hz
≦ 3 kHz	3 Hz to 100 Hz
≦ 10 kHz	3 Hz to 300 Hz
≦ 30 kHz	3 Hz to 1 kHz
≦ 100 kHz	3 Hz to 3 kHz
≦ 200 kHz	3 Hz to 10 kHz
> 200 kHz	3 Hz to 30 kHz

16 Increase ST until the UNCAL lamp goes out and the measured value no longer changes. Refer to 3.1.2 (1) STEP 1.

17 Directly connect OUTPUT–A and INPUT–T, then press the [X → S] key.

18 After one sweep measurement, turn on X–S lamp and connect INPUT–T to the output of the device under test.

19 Read the measured value.

Note

1. *MS560J – (A) can be controlled from MS560J – (B) as follows:*

   (a) Press the [BEGIN] key.

   (b) Press the [/] [1] [0] [EOL] keys in this order.

   (c) Press the [#] [1] , ["] ["] , [EOL] keys in this order.
   The part enclosed by ["] and ["] is the GP-IB control command. Refer to the GP-IB operation manual for details.

2. *The above operation can be program controlled by using the PTA1 option.*

SECTION 4 APPLICATION

CONTENTS

4.1 GENERAL DESCRIPTION 4-1
4.2 CRYSTAL AND CERAMIC FILTER 4-1
4.3 ACTIVE FILTER 4-2
4.4 OPERATIONAL AMPLIFIER 4-2
4.5 EQUALIZER 4-6
4.6 AGC CIRCUIT 4-7
4.7 OPTICAL ELEMENT 4-9
4.8 AM MODULATOR 4-10

SECTION 4 APPLICATION

4.1 GENERAL DESCRIPTION

The MS560J can measure and analyze many types of analog elements, circuits, devices and signals. The measuring method varies with different objects, but description is made here about the measuring method and rules on fundamental objects. Apply these procedures to similar devices not included in this manual.

Impedance measurement is the principal item of measurement on L, C, R and resonators. Refer to the "Impedance measuring kit operation manual" for measurement of these elements.

4.2 CRYSTAL AND CERAMIC FILTER

Taking advantage of the excellent stability and High-Q, these filters are often used as a narrow band-pass filter. They are indispensible in communication equipments.

The filters are evaluated by the following items:

(a) Insertion loss

(b) Pass-band ripple

(c) Pass-band group delay-time characteristics

(d) Pass band-width

(e) Center frequency

(f) Guaranteed attenuation (out of band)

(g) Attenuation slope

These items can be calculated from the transmission characteristics described in paragraph 3.1. High-speed *vary. (Avoid overload of device input)*

Note

1. *Narrow and sweep the RBW slowly when measuring an object with wide dynamic range.*
2. *The characteristics may change according to the testing level. Be sure to find the level range in which the characteristics do not vary. (Avoid overload of device input)*
3. *Generally, impedance conversion is required. Refer to paragraph 5.2.*
4. *Check if vibration changes the characteristics.*
5. *Measurement of typical crystal filter is explained in paragraph 3.1.2 through 3.1.4.*

4.3 ACTIVE FILTER

The active filter is used below several hundred kHz and consists of an operational amplifier, capacitors and resistors. Measurement of this filter is fundamentally the same as that of other filter. Pay attention to the fact that this filter has an operational amplifier as component.

Note

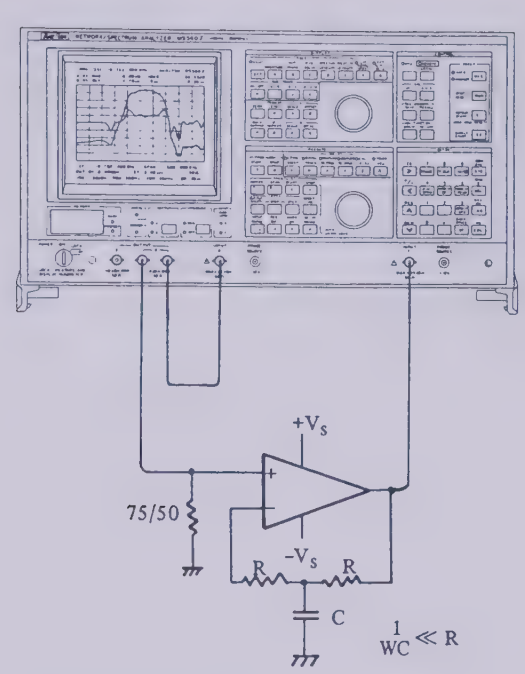
1. *Noise from the operational amplifier may narrow the dynamic range. For that reason, avoid measuring with inadequate device input levels.*
2. *Contrary to the above, excessive high levels may produce distortion and change the transmission characteristics of the operational amplifier, thus resulting in a change of filter characteristic. Choose the measuring level with utmost care.*

4.4 OPERATIONAL AMPLIFIER

An operational amplifier is one of the most fundamental elements which configure an analog circuit. Therefore, it is evaluated by many items. The measuring methods and results of some representative items are shown in Fig. 4-1 through Fig. 4-6.

Note

Since an operational amplifier has generally a large gain, care must be taken to present oscillations due to the test circuit.



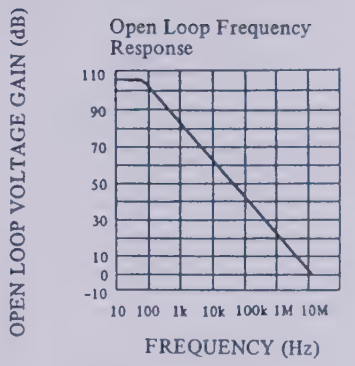
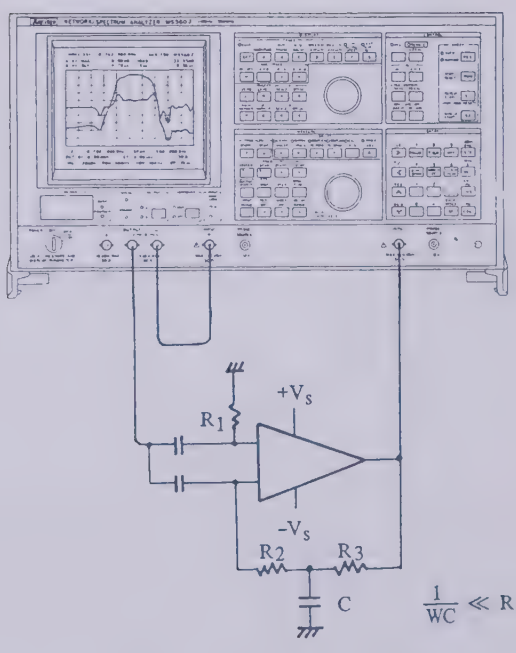


Fig. 4-1 Open Gain



$R_1 = R_2$; 75/50

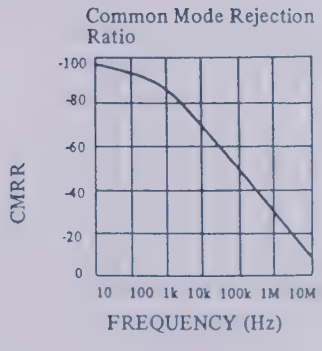
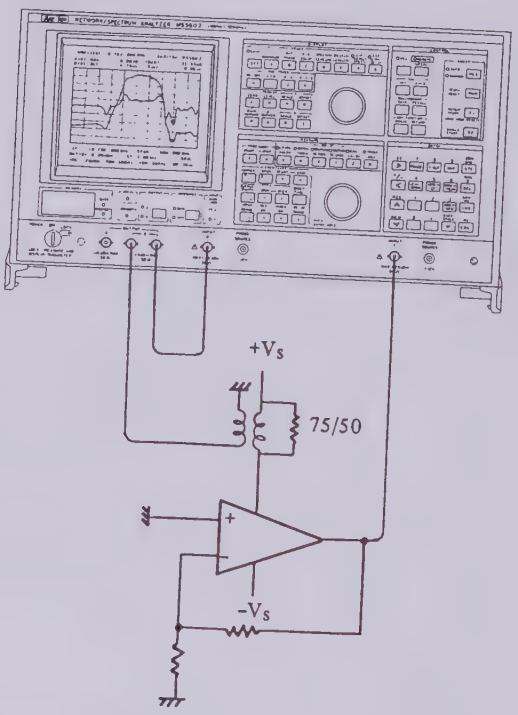


Fig. 4-2 CMRR



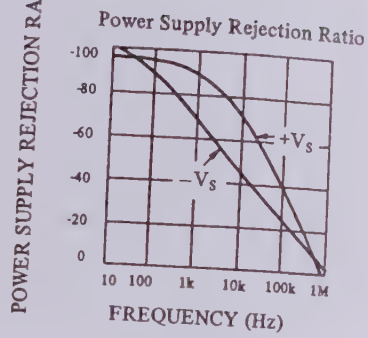


Fig. 4-3 Power Supply Rejection

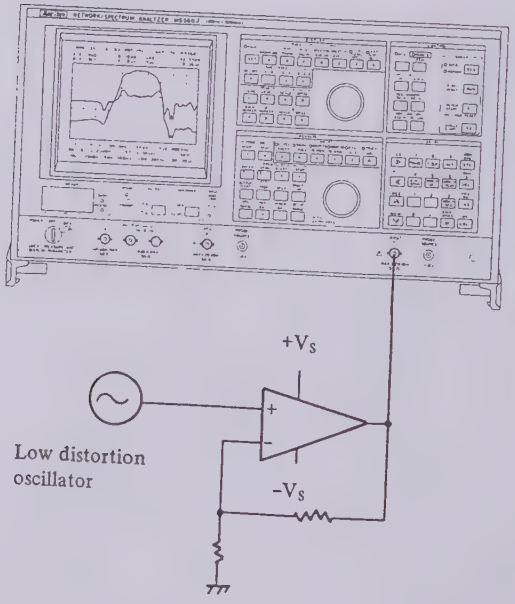


Fig. 4-4 Distortion

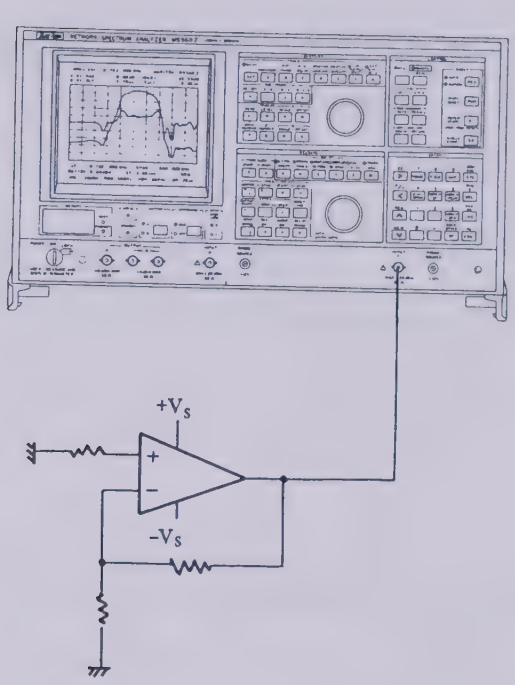


Fig. 4-5 Noise

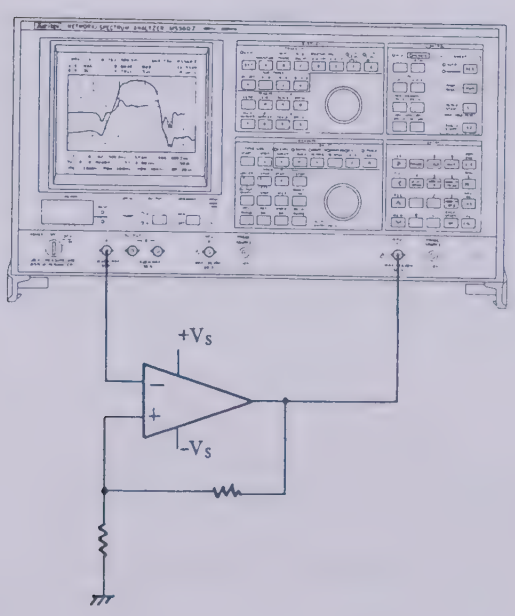


Fig. 4-6 Maximum Output Level

4.5 EQUALIZER

A high performance electronic device often uses an equalizer. The following are some examples of equalizer.

(a) Delay equalizer for band-pass filter

This is used to improve the frequency response of the group delay time of a band pass filter.

(b) Line amplifier for coaxial cable transmission

Since the transmission loss of a coaxial cable is proportional to $\sqrt{F}$, a line amplifier is designed to have the reverse characteristic to the above.

Note

F: frequency

(c) Dolby-IC

This is used to improve the high frequency noise characteristic of an audio tape recorder. Further, this equalization characteristic changes with input level changes.

Wide dynamic range and high accuracy in measurement are the common requirements of these equalizers. In such measurements, SUB TRACE (see paragraph 3.4) is conveniently used.

Note

1. *When the design values of an equalizer are set in the B-memory, the deviation from them is displayed on the screen by using the function B=A−B of the SUB TRACE.*
2. *PTA1 option or personal computer is used to set the design values in the B-memory.*
3. *The content of the B-memory can be backed up to PBM. For that reason, if the design values have been backed up to the PBM in advance, they can be used without the PTA1 and personal computer.*

4.6 AGC CIRCUIT

The AGC (Automatic Gain Control) circuit can be evaluated with the compressing and response characteristics, and loop stability.

(a) AGC circuit

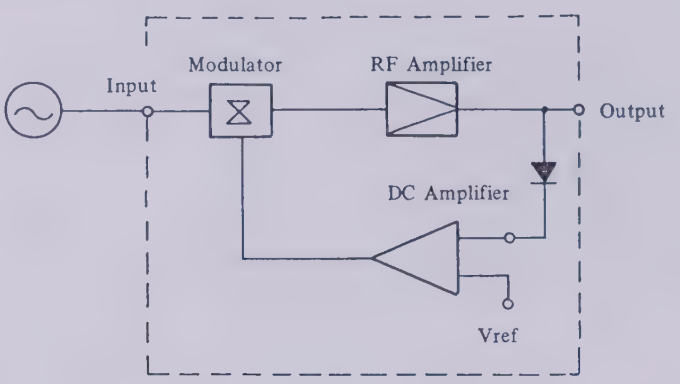


Fig. 4-7 AGC Circuit

(b) Compressing characteristic

This can be evaluated by the degree of output level change when the input signal level is varied. Measure the output level of the AGC circuit with sweeping the synthesizer output level. An example is shown in Fig. 4-8.

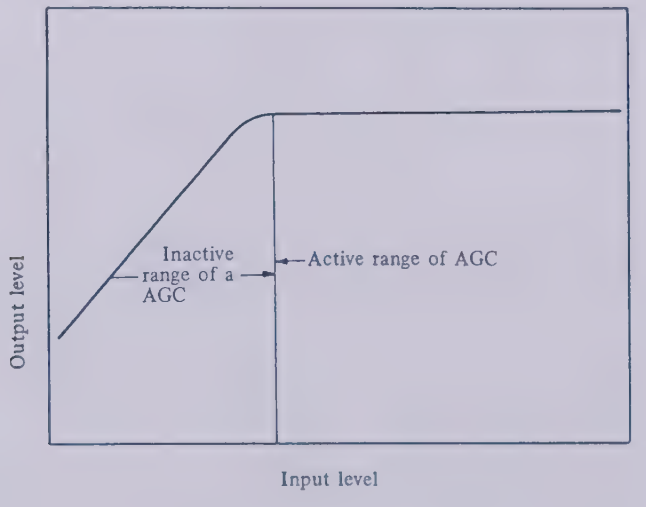
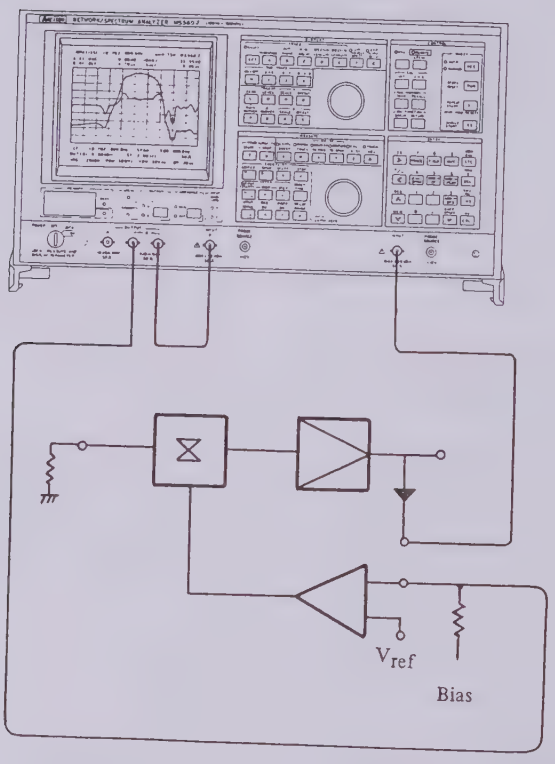
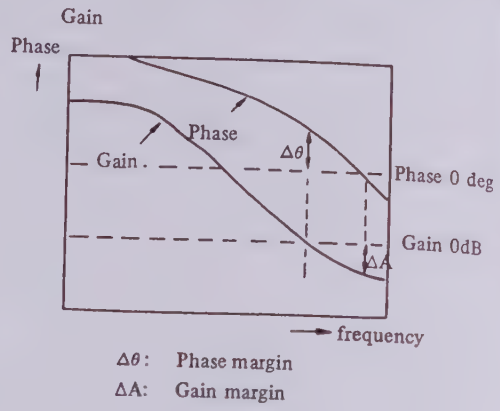


Fig. 4-8 Compression Characteristic

(c) Response time and loop stability

These can be evaluated measuring the loop gain. The response time can be judged by the frequency response of loop gain, and the loop stability by the gain and phase margins. The loop gain can be measured by the following connections. One example of frequency response of loop gain is shown in Fig. 4-9.





Δθ: Phase margin
ΔA: Gain margin

Fig. 4-9 Loop Gain

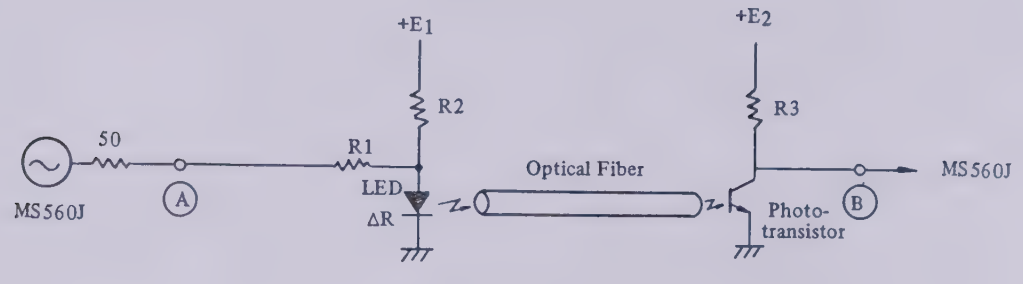
Note

1. *Since gain generally depends on bias (V ref), evaluate it at the worst value.*
2. *This measurement can be applied to PLL and AFC circuits.*

4.7 OPTICAL ELEMENT

Measurement of optical transmission line using LED, optical fiber and photo transistor is explained in the paragraph.

(a) Connection



ΔR : LED internal resistance
R2≫R1 R3 : 50 Ω
R1 = 50 Ω − ΔR

Fig. 4-10 Optical Element

Note

1. *Set the matching resistance, R1 to the value of 50 Ω minus LED internal resistance.*
2. *Give an appropriate dc. bias to LED.*
3. *If any two characteristics of the LED, fiber, and photo transistor are known, the other one can be determined.*

(b) Transmission characteristics

Measure the transmission characteristics between (A) and (B) according to pragraph 3.1.

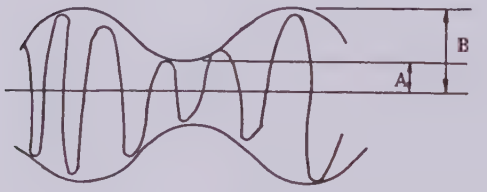
(c) Distortion

Connect a low distortion signal source to (A) of Fig. 4-10 and evaluate distortion from the spectrum at (B) point.

4.8 AM MODULATOR

The AM modulator is explained as follows.

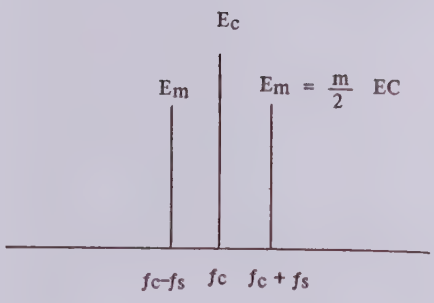
(1) Modulation factor



$$m = \frac{B - A}{A + B} \cdot 100\ (\%)$$

A and B is obtained on the video sweep.

(a) Time domain



$$m = \frac{2\,Em}{Ec} \cdot 100\ (\%)$$

(b) Frequency domain

Fig. 4-11 Modulation Factor

(2) Modulation distortion

Modulation distortion can be measured easily from the level difference between the fundamental wave and the spectrum of harmonic waves.

(3) Modulation frequency response

(a) Connection

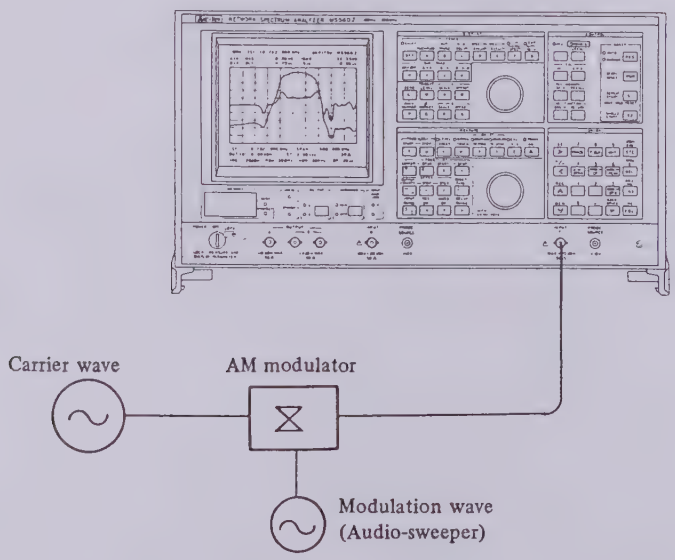


Fig. 4-12 Connection for Modulation Frequency Response Measurement

(b) Measuring example

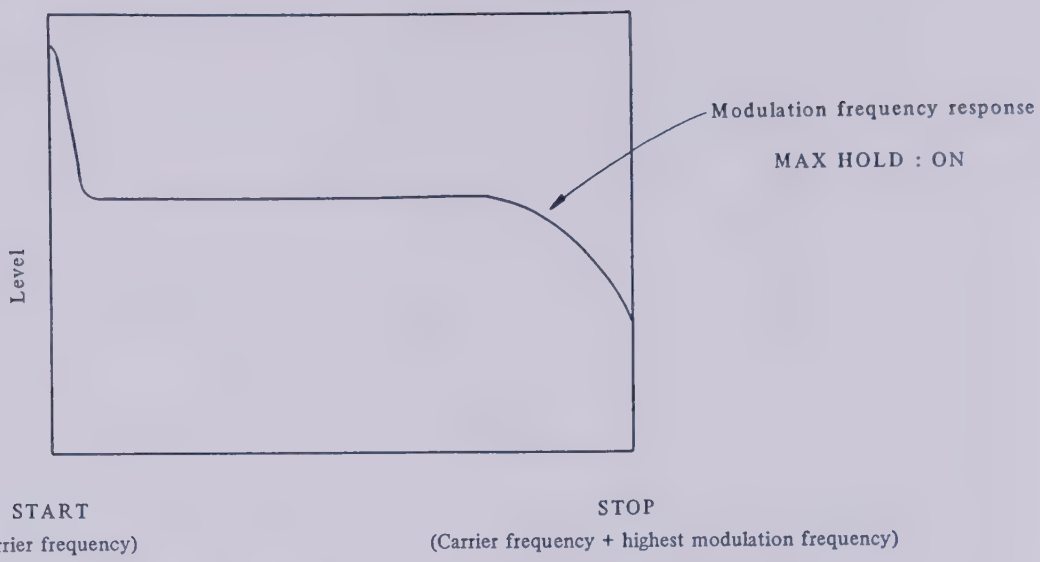


Fig. 4-13 Modulation Frequency Response

(4) Envelope measurement

Refer to paragraph 3.2.5

SECTION 5 PERFORMANCE TESTS

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SECTION 5 PERFORMANCE TESTS

5.1 INTRODUCTION AND DESCRIPTION

The MS560J (denoted as "TEST INSTRUMENT" in this section) performance is verified in Table 5-1.

The TEST PERFORMANCE SHEETS are from page 5-58 to 5-79.

Notes

1. *Specifications are guaranteed in the temperature range from 0°C to 50°C.*
2. *The TEST INSTRUMENT must warm up for at least 15 minutes, unless otherwise specified in the test procedures.*

Table 5-1 Calibration Description

TEST INSTRUMENT CHARACTERISTICS	PERFORMANCE SPECIFICATIONS	TEST METHOD
1. FREQUENCY RANGE	100 Hz to 300 MHz	
2. MEASUREMENT ITEMS	Magnitude, Phase, Delay, Level, Spectrum, Frequency, Envelope display.	
3. SAMPLING POINTS	251 points	
4. SWEEP TIME	500 ms* to 24 hours (*: Depends on measurement item and measurement conditions.)	
5. IMPEDANCE	50 Ω (Measurements for 75 Ω impedance are available when using the MA518A 75 Ω IMPEDANCE CONVERTER)	
6. SYNTHESIZER		
6.1 Frequency	100 Hz to 300 MHz, 0.1 Hz steps	Paragraph 5.4.1. Frequency is measured with a frequency counter.
6.2 Frequency Accuracy	$\pm 5 \times 10^{-8}$/day after 15 minutes warm-up at 23 ±5°C. $\pm 1 \times 10^{-7}$/year after 24 hours warm-up at 23 ±5°C. $\pm 1 \times 10^{-7}$/(0 to 50°C) after 15 minutes warm-up.	
6.3 Level	−110 to +10 dBm (OUTPUT-A), 0.01 dB steps. −110 to +4 dBm (OUTPUT-B), 0.01 dB steps.	

Table 5-1 Calibration Description (Cont'd)

TEST INSTRUMENT CHARACTERISTICS	PERFORMANCE SPECIFICATIONS	TEST METHOD
6.4 Level Accuracy	±0.4 dB : –40 to +10 dBm ±1.0 dB : –80 to –40 dBm (At OUTPUT-A)	Paragraph 5.4.2. Level is measured with a power meter, and attenuator.
6.5 Sideband Phase Noise	–85 dB/Hz at 10 kHz offset.	Paragraph 5.4.3. Sideband phase noise is measured with a spectrum analyzer.
6.6 Harmonic Distortion	–30 dB	Paragraph 5.4.4. Harmonic distortion is measured with a spectrum analyzer.
6.7 Spurious	–55 dB or –100 dBm	Paragraph 5.4.5. Spurious is measured with a spectrum analyzer.
6.8 Connector	BNC	
6.9 Impedance	Return loss : >20 dB (Output level is less than 0 dBm at OUTPUT-A terminal.)	Paragraph 5.4.6. Impedance is measured with the MS560J and a reflection bridge.
7. RECEIVER		
7.1 Frequency	100 Hz to 300 MHz	
7.2 Input Terminals	R and T (2 channels)	
7.3 Input Range	–40 to +20 dBm, 10 dB steps	
7.4 Maximum Input	+24 dBm AC $^{+1.5}_{-3.5}$ V DC	
7.5 Resolution Bandwidth Accuracy Selectivity	3 Hz to 30 kHz in 1, 3 sequences ±20 %, at ≧30 Hz 20/1, shape factor 60 dB/3 dB.	Paragraph 5.4.7. Resolution bandwidth is measured by receiving a single tone signal.
7.6 Video Bandwidth	3 Hz to 30 kHz in 1, 3 sequences.	
7.7 Average Noise Level		Paragraph 5.4.8. Average noise level is measured during no signal input.

Table 5-1 Calibration Description (Cont'd)

TEST INSTRUMENT CHARACTERISTICS	PERFORMANCE SPECIFICATIONS	TEST METHOD
7.8 Residual Response	–60 dB or –100 dBm	Paragraph 5.4.9. Residual response is measured during no signal input.
7.9 Connector	BNC	
7.10 Impedance	Return loss : 25 dB in greater than –10 dBm range.	Paragraph 5.4.10. Impedance is measured with the MS560J and a reflection bridge.
7.11 Crosstalk	100 dB : Between R and T channels	Paragraph 5.4.11. Crosstalk is measured by applying +10 dBm to INPUT-R at the –20 dBm range and MAGNITUDE.
8. MAGNITUDE		
8.1 Frequency	100 Hz to 300 MHz	
8.2 Range	±100 dB	
8.3 Resolution	0.01 dB	
8.4 Accuracy	±0.15 dB : 0 to –50 dB ±0.5 dB : –50 to –60 dB ±1 dB : –60 to –70 dB ±2 dB : –70 to –80 dB (At a 30 Hz of RBW, and 3 to 300 MHz frequency range)	Paragraph 5.4.12. Accuracy is determined by measuring the attenuator.
9. PHASE		
9.1 Frequency	100 Hz to 300 MHz	
9.2 Range	±180 deg	
9.3 Resolution	0.1 deg	
9.4 Accuracy	±1 deg at the some input level	Paragraph 5.4.13. Accuracy is determined by measuring a cable.
9.5 Level Characteristics	±1.5 deg : 0 to –50 dB ±3 deg : –50 to –70 dB (At a 30 Hz of RBW, and 3 to 300 MHz frequency range)	Paragraph 5.4.14. Level characteristics are determined by measuring phase at changing output level.

Table 5-1 Calibration Description (Cont'd)

TEST INSTRUMENT CHARACTERISTICS	PERFORMANCE SPECIFICATIONS	TEST METHOD
10. DELAY		
10.1 Frequency	100 Hz to 300 MHz	
10.2 Range	100 ns to 40 ms 17 ranges in 1, 2, 4 sequences	
10.3 Resolution	Normal : 1/1000 of range Expanded : 1/10000 of range	
10.4 Accuracy	±0.5 % of range : 0 to −50 dB ±2.0 % of range : −50 to −70 dB (At a 30 Hz of RBW, and 3 to 300 MHz frequency range)	Paragraph 5.4.15. Accuracy is determined by measuring the cable.
11. LEVEL		
11.1 Frequency	100 Hz to 300 MHz	
11.2 Range	−140 to +20 dBm	
11.3 Resolution	0.01 dB	
11.4 Accuracy	±0.5 dB : +20 to −90 dBm ±1.0 dB : −90 to −100 dBm ±3.0 dB : −100 to −120 dBm (At 30 Hz of RBW, and 3 to 300 MHz frequency range)	Paragraph 5.4.16. Accuracy is determined by the sum of linearity error (Item 11.5) and synthesizer level accuracy (Paragraph 5.4.2), after rejecting the detuning error.
11.5 Linearity	±0.15 dB : 0 to −50 dB ±1.0 dB : −50 to −60 dB ±3.0 dB : −60 to −70 dB (At 30 Hz of RBW, and 3 to 300 MHz frequency range)	Linearity is determined by measuring the attenuator.
12. SPECTRUM		
12.1 Image Rejection	70 dB	Paragraph 5.4.17. Image rejection is measured by receiving image frequency signals.
12.2 IF Rejection	70 dB	Paragraph 5.4.18 IF rejection is measured by receiving the IF frequency signal when not tuned to IF frequency.

Table 5-1 Calibration Description (Cont'd)

TEST INSTRUMENT CHARACTERISTICS	PERFORMANCE SPECIFICATIONS	TEST METHOD
12.3 Internal Distortion	–50 dB at 100 Hz to 3 MHz and RBWS ≦ 300 Hz. –60 dB at 3 to 300 MHz.	Paragraph 5.4.19. Internal distortion is measured by receiving a non-harmonic-distortion signal.
12.4 Spurious	–60 dB	Paragraph 5.4.20. Spurious is measured by receiving pure single tone signal.
13. FREQUENCY COUNT		
13.1 Frequency	100 Hz to 300 MHz	
13.2 Resolution	1 Hz	
13.3 Accuracy	$\pm(5 \times 10^{-8} + 2$ Hz)/day after 15 minutes warm-up at 23 ±5°C. $\pm(1 \times 10^{-7} + 2$ Hz)/year after 24 hours warm-up at 23 ±5°C. $\pm(1 \times 10^{-7} + 2$ Hz)/0 to 50°C after 15 minutes warm-up. (At a signal 20 dB greater than other signals and with noise in the filter skirts, marker is set to the maximum value of the object signals)	Paragraph 5.4.21. Accuracy is determined by receiving a known frequency signal.
14. ENVELOPE DISPLAY		
14.1 Carrier Frequency	100 Hz to 300 MHz	
14.2 Sweep Time	100 ms to at least 100 sec.	
14.3 Envelope Frequency	DC to 200 Hz (Depends on RBW and VBW)	

5.2 EQUIPMENT REQUIREMENTS

Note

Minimum use specifications are the principal parameters required for performance of the calibration, and are included to assist in the selection of alternate equipment. Satisfactory performance of alternate items should be verified prior to use. All applicable equipment must bear evidence of current calibration.

Table 5-2 Equipment Requirements

Item	Genetic Term	Minimum Use Specifications	Calibration Equipment
T5.2.1	Frequency counter	o Frequency range 100 Hz to 300 MHz o Accuracy 1×10^{-8} o Sensitivity 10 mV to 1 Vrms	MF57A (Anritsu)
T5.2.2	Power meter	o Frequency range 100 Hz to 300 MHz o Accuracy 0.05 dB o Sensitivity –10 to 0 dBm	EPM-1 with TK-10 BN564-01 (Wandel & Goltermann)
T5.2.3	Spectrum analyzer	o Frequency range 100 kHz to 1 GHz o Dynamic range 70 dB	MS62A, MS611A (Anritsu)
T5.2.4	Network analyzer	o Frequency range 100 Hz to 300 MHz o Dynamic range 100 dB	MS560J (Anritsu)
T5.2.5	Reflection bridge	o Frequency range 10 MHz to 300 MHz o Directivity 40 dB	62B50 (Willtron)
T5.2.6	Frequency synthesizer	o Frequency range 100 kHz to 1.5 GHz o Spurious –70 dBc o Frequency accuracy 1×10^{-8}	MG545A MG639A (Anritsu)

Table 5-2 Equipment Requirements (Cont'd)

Item	Genetic Term	Minimum Use Specifications	Calibration Equipment
T5.2.7	Attenuator Note (1)	o Frequency range 100 Hz to 300 MHz o Attenuation 0 to 80 dB o Accuracy 0.03 dB : 0 to 50 dB 0.1 dB : 50 to 60 dB 0.2 dB : 60 to 70 dB 0.5 dB : 70 to 80 dB	MN510C (Anritsu)
T5.2.8	Standard cable	o Frequency 100 Hz to 300 MHz o Length 200 m, 20 m, 2 m, 0 m	
T5.2.9	Low pass filter	o Frequency 100 kHz to 300 MHz o Stop band loss 40 dB	
T5.2.10	RC oscillator	o Frequency 100 Hz to 50 kHz o Distortion 0.01 %	VP7220C (National)

Note

(1) If the attenuator shows an error greater than ±0.03 dB, it must be calibrated by the standards lab to obtain the correction factors.

5.3 PRELIMINARY OPERATIONS

(1) Turn on the power of the TEST INSTRUMENT.

(2) Warm-up the TEST INSTRUMENT for at least 15 minutes until the WARM UP display on the SCREEN disappears.

Note

In the frequency accuracy test, warm-up the TEST INSTRUMENT according to calibration procedure for this test.

5.4 CALIBRATION PROCEDURE

Note

Unless otherwise specified, verify the results of each test and take corrective action whenever the test requirement is not met.

5.4.1 Frequency Accuracy of Synthesizer Output

Synthesizer output frequency is measured directly with the FREQUENCY COUNTER. Prior to this test, verify that the reference crystal oscillator of the FREQUENCY COUNTER has been calibrated with a 1×10^{-8} or less stabilized standard signal. Otherwise, use an external standard signal having the same stability as reference.

(1) Specifications

(a) $\pm 5 \times 10^{-8}$/day after 15 minutes warm-up at 23 ±5°C.

(b) $\pm 1 \times 10^{-7}$/year after 24 hours warm-up at 23 ±5°C.

(c) $\pm 1 \times 10^{-7}$/0 to 50°C after 15 minutes warm-up.

(2) Set-up

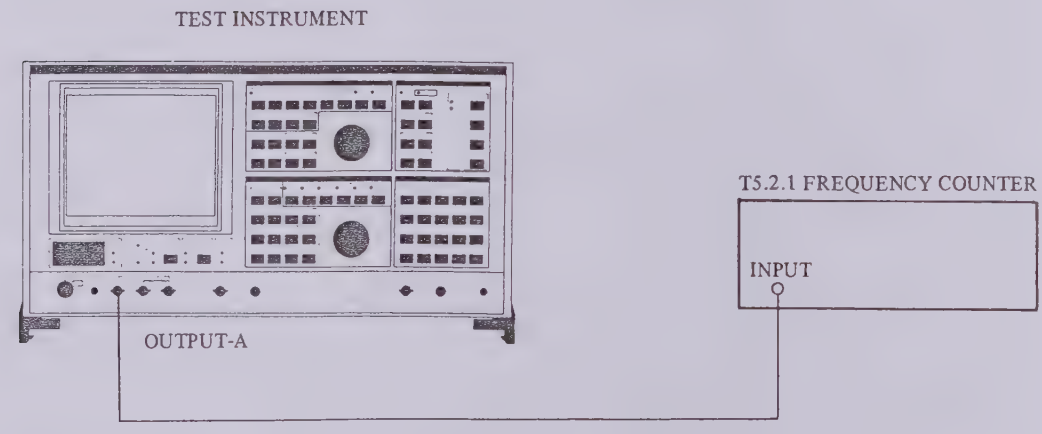


Fig. 5-1 Frequency Accuracy of Synthesizer Output

(3) Procedures

Step	Procedure
1	Set up the TEST INSTRUMENT and FREQUENCY COUNTER as shown in Fig. 5-1.
2	Turn on the FREQUENCY COUNTER.

Note

The FREQUENCY COUNTER must warm up until its measuring accuracy is at least 1×10^{-8}, or, it must be synchronized by external standards.

3	Connect the power cord of the TEST INSTRUMENT to an AC line.

Note

The TEST INSTRUMENT must not be connected to the AC line before this step, because the standard oscillator of the TEST INSTRUMENT is standing by.

4	Turn on the TEST INSTRUMENT.
5	Wait for at least 15 minutes after step 3.
6	Set the TEST INSTRUMENT as follows: OUTPUT ..... A CF ..... 100 MHz AUTO/MARKER ..... MARKER
7	Read the FREQUENCY COUNTER indication (fm).
8	Frequency accuracy is expressed by the following formula: $\text{Frequency accuracy} = \frac{100{,}000{,}000 - \text{fm (Hz)}}{100{,}000{,}000 \text{ (Hz)}}$

Notes

a. For measuring long term stability, read the FREQUENCY COUNTER indication every 24 hours and every year.

b. For measuring temperature stability, place the TEST INSTRUMENT in a room with constant temperature, and read the FREQUENCY COUNTER indication at all temperatures.

5.4.2 Level Accuracy of Synthesizer Output

A 0 dBm output level of the synthesizer is measured with the POWER METER, and the other levels are measured with the TEST INSTRUMENT by inserting an ATTENUATOR equivalent to the level difference between 0 dBm and each level.

(1) Specifications

±0.4 dB : −40 to +10 dBm
±1 dB : −80 to −40 dBm
(At OUTPUT-A)

(2) Set-up

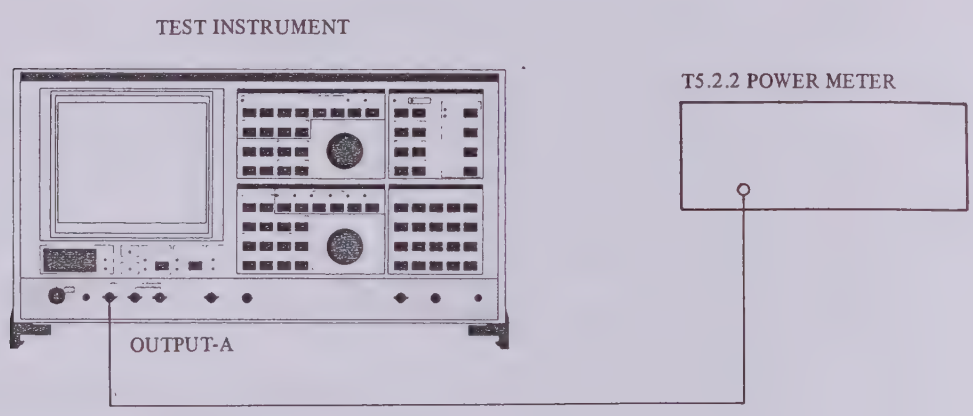


Fig. 5-2 Level Accuracy at 0 dBm

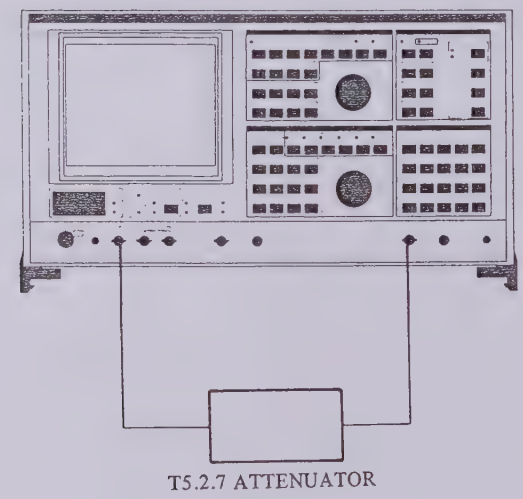


Fig. 5-3 Step Error for Level Accuracy

(3) Procedures

Step	Procedure
1	Set up the TEST INSTRUMENT and POWER METER as shown in Fig. 5-2.
2	Turn on the TEST INSTRUMENT, and wait for at least 15 minutes.

Note

If the TEST INSTRUMENT has been turned on, press the [RECALL] and [9] keys in this order for initializing the TEST INSTRUMENT at power-ON.

3 Set the TEST INSTRUMENT as follows:

OUTPUT ..... A
AUTO/MARKER ..... MARKER
OUTPUT LEVEL ..... 0 dBm

4 Press the [REPEAT START] key.

5 Set the frequency of the TEST INSTRUMENT by choosing a frequency from the following table.

100 Hz, 10 kHz, 1 MHz, 10 MHz, 100 MHz, 200 MHz, 300 MHz

6 Read the POWER METER indication.

7 Repeat steps 5 and 6 for measuring the output level of the synthesizer over all the frequencies as shown in step 5.

8 Set up the TEST INSTRUMENT and ATTENUATOR as shown in Fig. 5-3.

9 Press the [RECALL] and [9] keys in this order, for initializing the TEST INSTRUMENT at power-ON.

10 Press the [REPEAT START] key.

11 Set the TEST INSTRUMENT as follows:

- LOG START ..... 10 MHz
- LOG STOP ..... 300 MHz
- OUTPUT ..... A
- TRACE ..... LEVEL (T)
- RBW ..... 100 Hz
- VBW ..... 300 Hz

Step	Procedure
12	Adjust the SWEEP · TIME so that the UNCAL lamp does not light.
13	Set the TEST INSTRUMENT to 0 dBm – output, and set the ATTENUATOR to 0 dB-attenuation.
14	Press the [X→S] key, and wait for completion of one sweep measurement.
15	Turn on the X–S lamp.
16	Set the ATTENUATOR to 10 dB-attenuation, and set the TEST INSTRUMENT to 10 dBm-output.
17	The output level step error between 0 dBm and 10 dBm will be displayed on the SCREEN.
18	Set the TEST INSTRUMENT to 0 dBm-output, and set the ATTENUATOR to 10 dB-attenuation (A).
19	Press the [X→S] key, and wait for completion of one sweep measurement.
20	Set the TEST INSTRUMENT to –10 dBm-output (B), and set the ATTENUATION to 0 dB-attenuation.
21	The output level step error between 0 dBm and –10 dBm (B) will be displayed on the SCREEN.
22	Repeat steps 18 to 21, varying A from 20 dB to 80 dB in 10 dB steps and B from –20 dBm to –80 dBm in 10 dB steps.
	Note
	If A is greater than 50 dB, set the TEST INSTRUMENT to a –40 dBm-input-range.

5.4.3 Sideband Phase Noise of Synthesizer Output

Sideband phase noise is measured with a spectrum analyzer.

(1) Specifications

–85 dB/Hz at 10 kHz offset

(2) Set-up

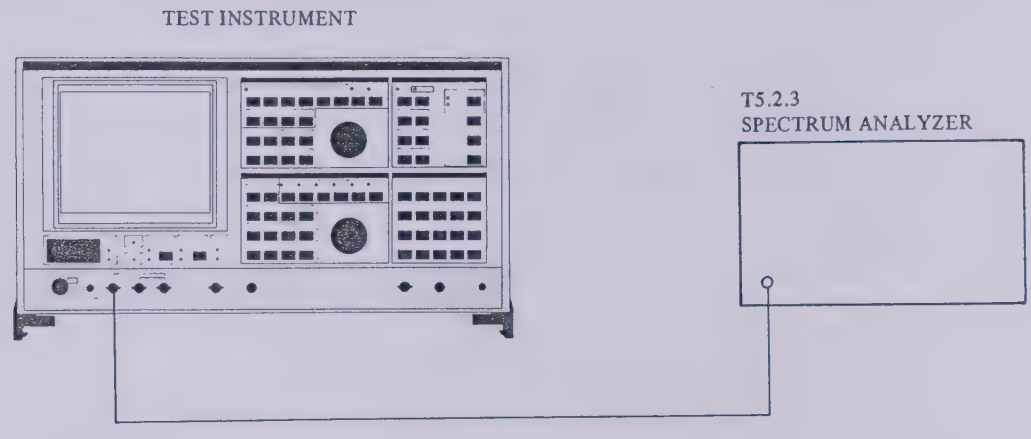


Fig. 5-4 Sideband Phase Noise of Synthesizer Output

(3) Procedure

Step	Procedure
1	Set up the TEST INSTRUMENT and SPECTRUM ANALYZER as shown in Fig. 5-4.
2	Turn on the TEST INSTRUMENT, and wait for at least 15 minutes.

Note

If the TEST INSTRUMENT has been turned on, press the [RECALL] and [9] keys in this order for initializing the TEST INSTRUMENT at power-ON.

Step	Procedure

3 Set the TEST INSTRUMENT as follows:

OUTPUT ..... A
AUTO/MARKER ..... MARKER
OUTPUT LEVEL ..... 0 dBm

4 Press the [REPEAT START] key.

5 Set the frequency of the TEST INSTRUMENT by choosing a frequency from the following table.

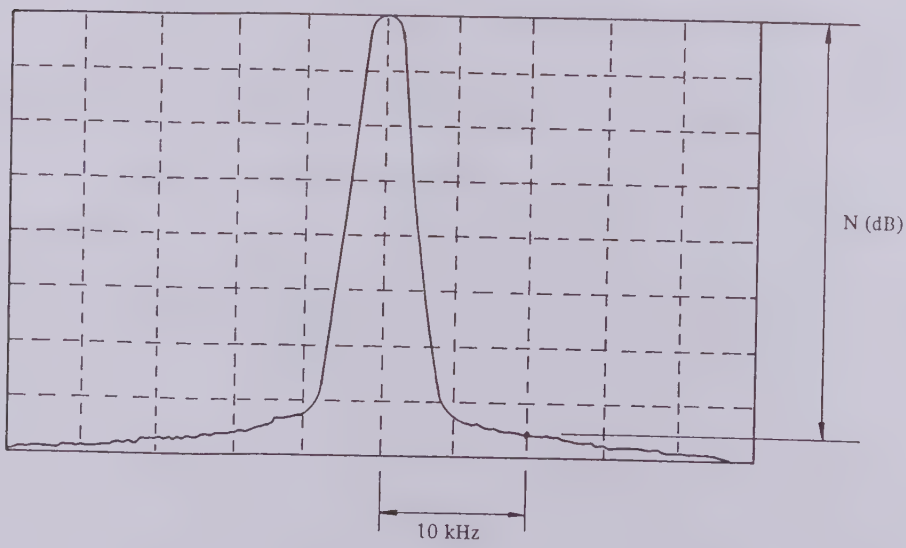
1 MHz, 10 MHz, 100 MHz, 200 MHz, 300 MHz.

6 Set the center frequency of the SPECTRUM ANALYZER to the frequency set at step 5.

7 Set the SPECTRUM ANALYZER as follows:

SPAN ..... 50 kHz
RBW ..... 300 Hz
REFERENCE LEVEL .... 0 dBm
VBW ..... ON

8 Read the noise level from the SPECTRUM ANALYZER referring to the following figure.



Step	Procedure
	In this case, the sideband phase noise (C/N) is expressed in the following formula: C/N = N + 25 (dBc/Hz)
9	For measuring the sideband phase noise of the synthesizer over all the frequencies as shown in step 5, repeat between steps 5 and 9.

5.4.4 Harmonic Distortion of Synthesizer Output

Harmonic distortion is measured with a spectrum analyzer.

(1) Specifications

–30 dB

(2) Set-up

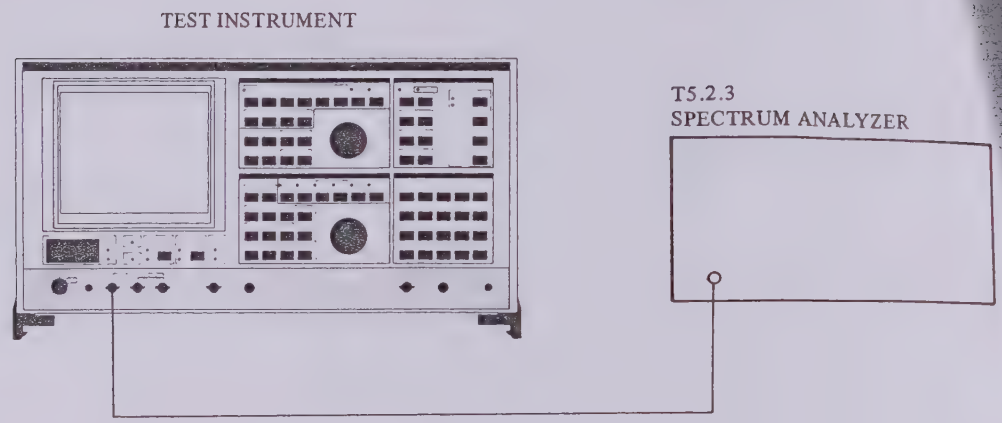


Fig. 5-5 Harmonic Distortion of Synthesizer Output

(3) Procedures

Step	Procedure
1	Set up the TEST INSTRUMENT and SPECTRUM ANALYZER as shown in Fig. 5-5.
2	Turn on the TEST INSTRUMENT and wait for at least 15 minutes.

Note

If the TEST INSTRUMENT has been turned on, for initializing the TEST INSTRUMENT at power-ON, press the [RECALL] *and* [9] *keys, in this order.*

Step	Procedure

3 Set the TEST INSTRUMENT as follows:

OUTPUT ..... A
AUTO/MARKER ..... MARKER
OUTPUT LEVEL ..... 0 dBm

4 Press the [REPEAT START] key.

5 Set the frequency of the TEST INSTRUMENT to one of the frequencies shown in the following table.

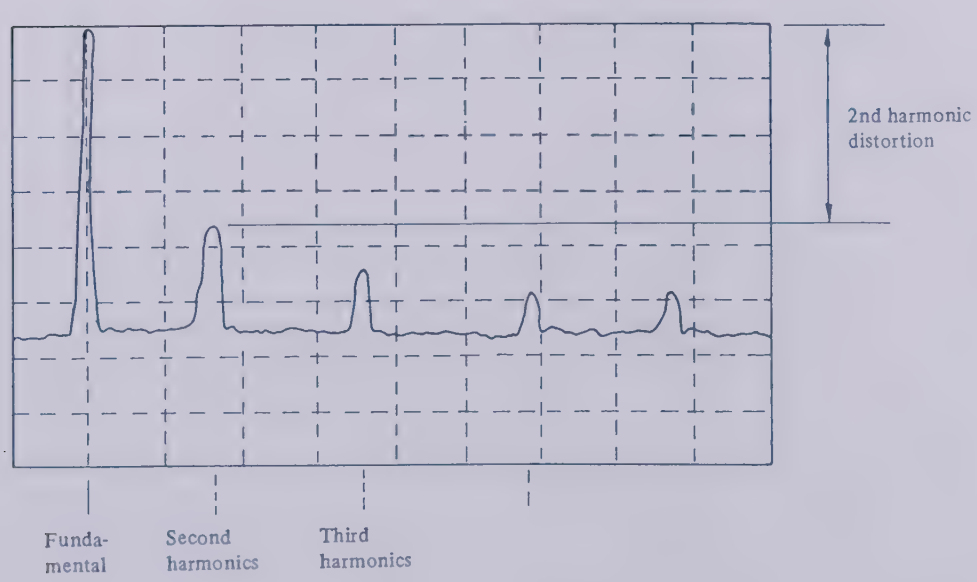
1 MHz, 10 MHz, 100 MHz, 200 MHz, 300 MHz.

6 Set the start frequency of the SPECTRUM ANALYZER to 0.9 x fo —— fo is the frequency set at step 5 ——, and set the stop frequency to 6 x fo.

7 Set the SPECTRUM ANALYZER and follows:

RBW ..... 10 kHz or 100 kHz
REFERENCE LEVEL .... 0 dBm

8 Read the harmonic distortion from the SPECTRUM ANALYZER referring to the following figure.



Step	Procedure
9	For measuring the harmonic distortion of the synthesizer over all the frequencies, as shown in step 5, repeat between steps 5 and 8.

5.4.5 Spurious of Synthesizer Output

Spurious is measured with a spectrum analyzer.

(1) Specifications

–55 dB or –100 dBm

(2) Set-up

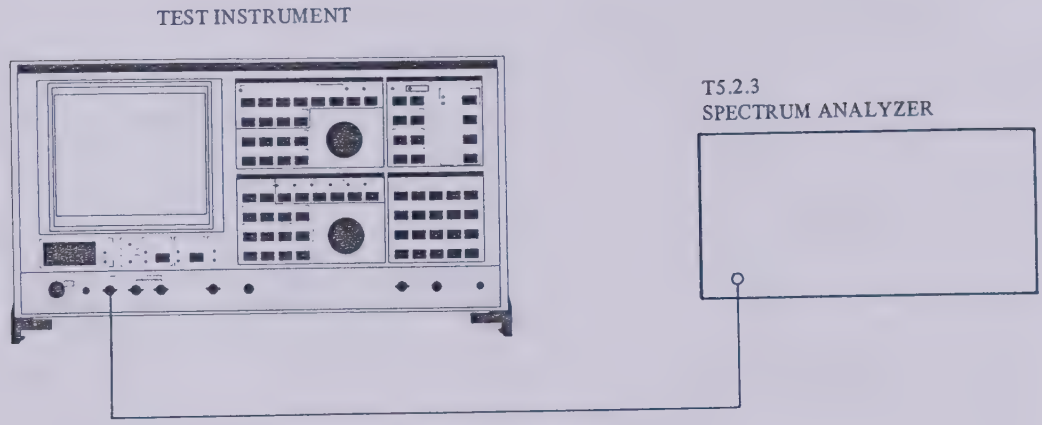


Fig. 5-6 Spurious of Synthesizer Output

(3) Procedures

Step	Procedure
1	Set up the TEST INSTRUMENT and SPECTRUM ANALYZER as shown in Fig. 5-6.
2	Turn on the TEST INSTRUMENT, and wait for at least 15 minutes.

Note

If the TEST INSTRUMENT has been turned on, press the [RECALL] and [9] keys in this order for initializing the TEST INSTRUMENT at power-ON.

Step	Procedure
3	Set the TEST INSTRUMENT as follows: OUTPUT ..... A OUTPUT LEVEL ..... 0 dBm SWEEP TIME ..... 100 sec.
4	Press the [REPEAT START] key.
5	Read the spurious, with the exception of harmonics, on the SPECTRUM ANALYZER screen over all the output frequencies.

5.4.6 Impedance of Synthesizer Output

Return loss of synthesizer output is measured with a network analyzer.

(1) Specifications

Return loss : 20 dB
(Output level is less than 0 dBm at OUTPUT-A terminal.)

(2) Set-up

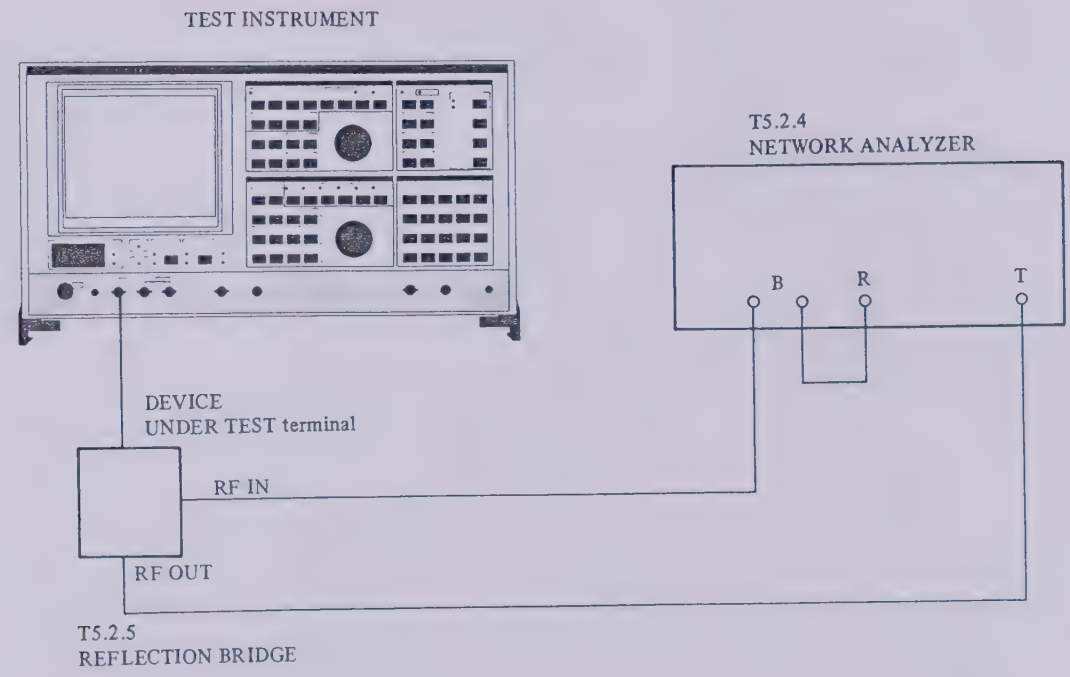


Fig. 5-7 Impedance of Synthesizer Output

(3) Procedures

Step	Procedure
1	Set up the TEST INSTRUMENT, REFLECTION BRIDGE, and NETWORK ANALYZER as shown in Fig. 5-7.
2	Turn on the TEST INSTRUMENT, and wait for at least 15 minutes.

Step	Procedure
	Note *If the TEST INSTRUMENT has been turned on, press the [RECALL] and [9] keys in this order for initializing the TEST INSTRUMENT at power-ON.*
3	Set the TEST INSTRUMENT as follows: OUTPUT . . . . . A
4	Set the NETWORK ANALYZER as follows: START FREQUENCY . . . . 10 MHz STOP FREQUENCY . . . . . 300 MHz
5	Press the [REPEAT START] key.
6	Remove the cable connected to the DEVICE UNDER TEST terminal of the REFLECTION BRIDGE.
7	Press the [X → S] key of the NETWORK ANALYZER, and wait until completion of one sweep measurement.
8	Turn on the X-S lamp.
9	Connect OUTPUT-A of the TEST INSTRUMENT and DEVICE UNDER TEST terminal of the REFLECTION BRIDGE.
10	Read the maximum value on the NETWORK ANALYZER screen as return loss of synthesizer output.

5.4.7 Resolution Bandwidth of Receiver

Resolution bandwidth (RBW) is evaluated by measuring both 3 dB and 60 dB bandwidth of the IF band-pass filter. However, RBW 10 kHz is evaluated by measuring a 50 dB bandwidth instead of a 60 dB bandwidth because sideband phase noise of local oscillator is insufficient for RBW 10 kHz.

(1) Specifications

3 dB bandwidth : 3 Hz to 30 kHz in 1, 3 sequences
Accuracy ±20 % at ≧30 Hz

Selectivity : 20/1, shape factor 60 dB/3 dB

(2) Set-up

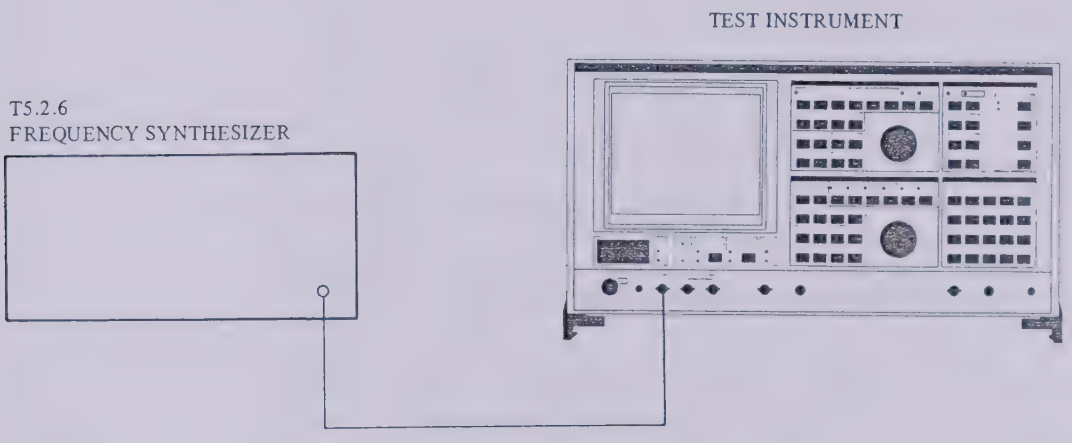


Fig. 5-8 Resolution Bandwidth of Receiver

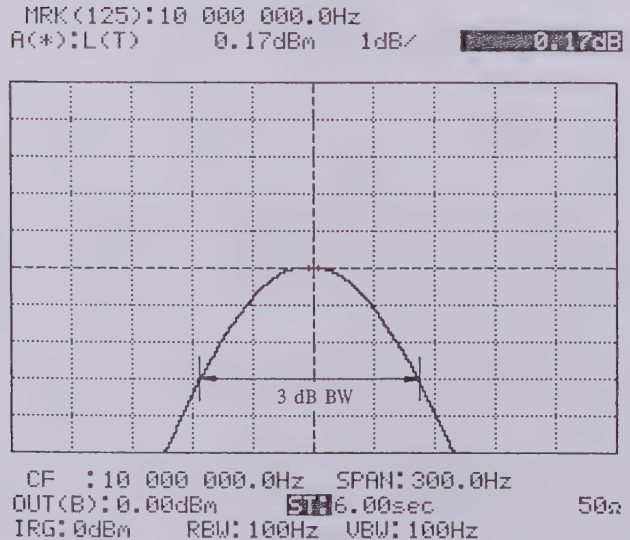
(3) Procedures

Step	Procedure
1	Set up the TEST INSTRUMENT and FREQUENCY SYNTHESIZER as shown in Fig. 5-8.
2	Turn on the TEST INSTRUMENT, and wait for at least 15 minutes.

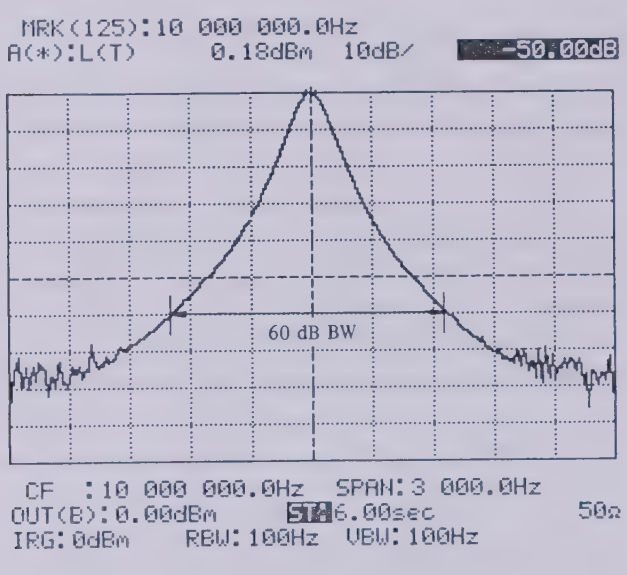
Note

If the TEST INSTRUMENT has been turned on, press the [RECALL] and [9] keys in this order for initializing the TEST INSTRUMENT at power-ON.

Step	Procedure
3	Set the FREQUENCY SYNTHESIZER as follows: FREQUENCY ..... 10 MHz OUTPUT LEVEL ..... 0 dBm
4	Press the [REPEAT START] key.
5	Set the TEST INSTRUMENT as follows: TRACE ..... LEVEL (R) or LEVEL (T) CF ..... 10 MHz IRG ..... 0 dBm
6	Set RBW, VBW, and SPAN FREQUENCY (A) of the TEST INSTRUMENT to one of Table 5-3.
7	Set the SWEEP TIME so that the UNCAL lamp does not light.
8	Set the SCALE-A of the TEST INSTRUMENT to 1 dB/div.
9	After completion of one sweep measurement, press the [RECALL] and [6] key, and press the [RECALL] and [5] key.
10	Determine the 3 dB bandwidth referring to the following figure.



Step	Procedure
11	Set the SPAN FREQUENCY (B) according to Table 5-3, in the same RBW and VBW set at step 6.
12	Set the SWEEP TIME so that the UNCAL lamp does not light.
13	Set the SCALE to 10 dB/div, and set the OFFSET to about −50 dB.
14	After completion of one sweep measurement, determine the 60 dB bandwidth referring to the following figure.



15 Shape factor is expressed by the following formula.

$$\text{Shape factor} = \frac{\text{60 dB bandwidth}}{\text{3 dB bandwidth}}$$

Step | Procedure

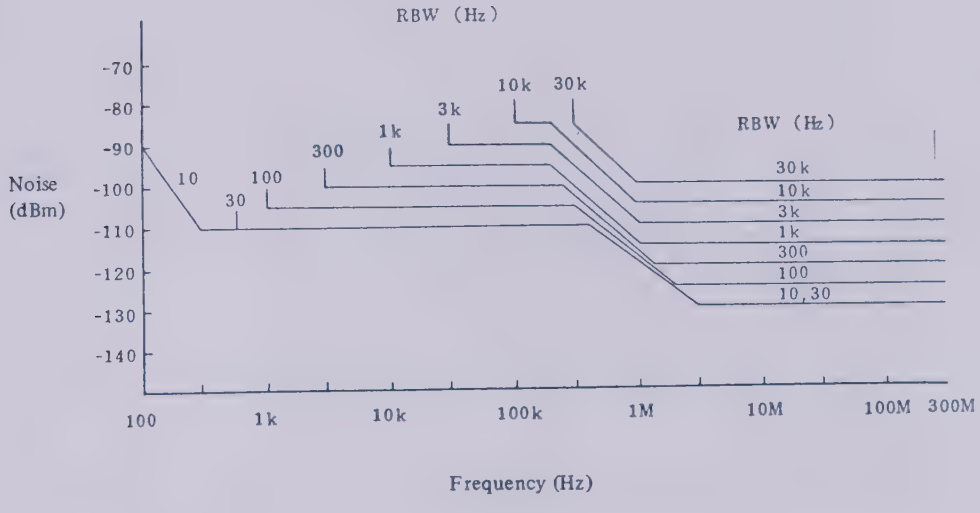
Table 5-3 Selectivity of RBW

RBW/VBW		SPAN FREQ	
		(A) 3 dB MEASUREMENT	(B) 60 dB MEASUREMENT
1	3 Hz	10 Hz	100 Hz
2	10 Hz	30 Hz	300 Hz
3	30 Hz	100 Hz	1 kHz
4	100 Hz	300 Hz	3 kHz
5	300 Hz	1 kHz	10 kHz
6	1 kHz	3 kHz	30 kHz
7	3 kHz	10 kHz	100 kHz
8	10 kHz	30 kHz	300 kHz
9	30 kHz	100 kHz	1 MHz

5.4.8 Average Noise Level of Receiver

Average noise level can be evaluated by measuring input level during no signal input. However, residual response is measured in paragraph 5.4.9.

(1) Specifications



(2) Set-up

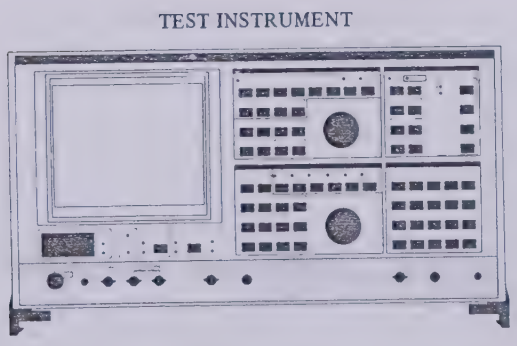


Fig. 5-9 Average Noise Level of Receiver

(3) Procedures

Step	Procedure
1	Remove all cables connected to the TEST INSTRUMENT front panel.
2	Turn on the TEST INSTRUMENT, and wait for at least 15 minutes.
	Note *If the TEST INSTRUMENT has been turned on, press the* [RECALL] *and* [9] *keys in this order for initializing it at power-ON.*
3	Set the TEST INSTRUMENT as follows: LOG START ..... 100 Hz LOG STOP ..... 10 MHz IRG ..... –40 dBm TRACE ..... LEVEL (R) or LEVEL (T) OUTPUT LEVEL ..... –40 dBm OFFSET ..... –100 dB
4	Set RBW and VBW to 10 Hz, and set SWEEP TIME so that the UNCAL lamp does not light.
5	Press the [SINGLE START] key.
6	After completion of one sweep measurement, determine the average noise level.
7	Measure the average noise level in all RBW.
8	Set the TEST INSTRUMENT as follows: LOG START ..... 10 MHz LOG STOP ..... 300 MHz
9	Measure the average noise level in all RBW.

5.4.9 Residual Response of Receiver

Residual response at no input signal will appear at the specific frequencies.

(1) Specifications

−60 dB or −100 dBm

(2) Set-up

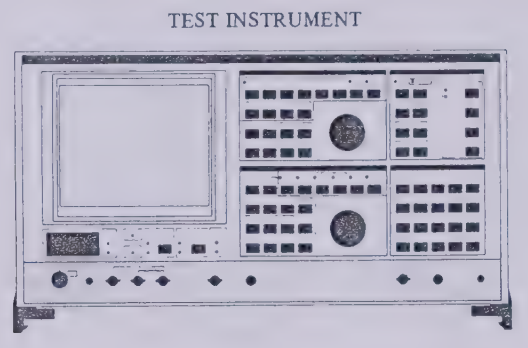


Fig. 5-10 Residual Response of Receiver

(3) Procedure

Step	Procedure
1	Remove all cables connected to the TEST INSTRUMENT front panel.
2	Turn on the TEST INSTRUMENT, and wait for at least 15 minutes.

Note

If the TEST INSTRUMENT has been turned on, press the [RECALL] *and* [9] *keys in this order for initializing it at power-ON.*

3 Set the TEST INSTRUMENT as follows:

IRG ..... −40 dBm
TRACE ..... LEVEL (R) or LEVEL (T)
OUTPUT LEVEL ..... −40 dBm
OFFSET ..... −100 dB
SPAN ..... 500 Hz

Step	Procedure
4	Set the CF to one of the frequencies shown in the following table. 100 kHz, 1 MHz, 2 MHz, 10 MHz, 20 MHz, 6.25 MHz, 12.5 MHz, 18.75 MHz, 25.0 MHz, 31.25 MHz, 50 MHz, 100 MHz, 150 MHz, 200 MHz, 250 MHz, 300 MHz, 214.95 MHz, 271.65 MHz, 124.4 MHz, 162.2 MHz, 79.125 MHz, 107.475 MHz, 229.125 MHz, 257.475 MHz, 51.96 MHz
5	Measure the spurious response.

5.4.10 Input Impedance of Receiver

Input impedance is measured with a reflection bridge and a network analyzer.

(1) Specifications

25 dB in return loss at greater than −10 dBm range.

(2) Set-up

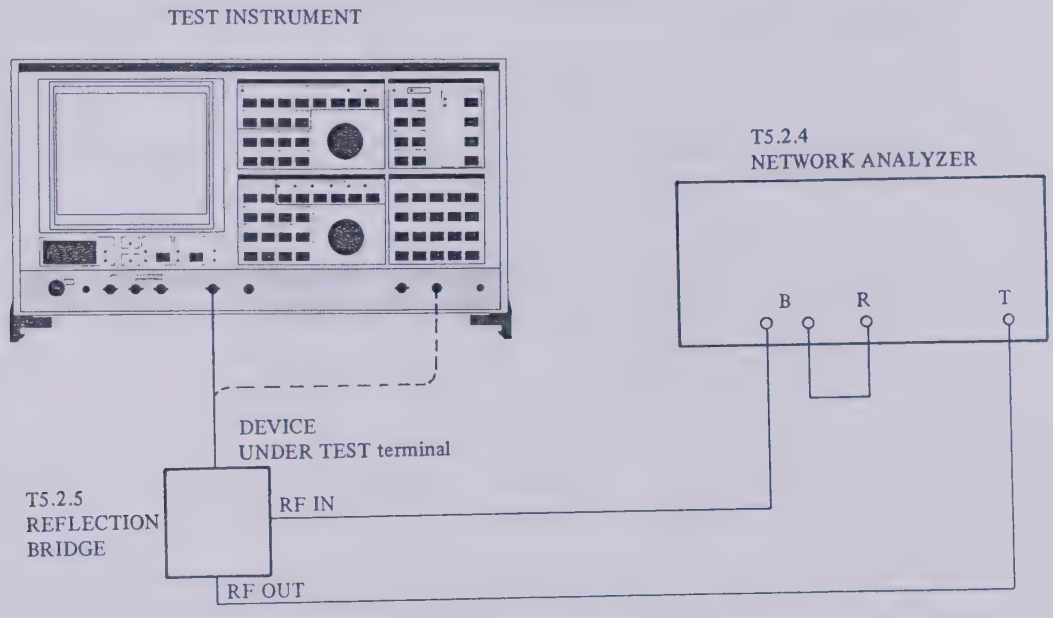


Fig. 5-11 Input Impedance of Receiver

(3) Procedures

Step	Procedure
1	Set up the TEST INSTRUMENT, REFLECTION BRIDGE, and NETWORK ANALYZER as shown in Fig. 5-11.
2	Turn on the TEST INSTRUMENT, and wait for at least 15 minutes.

Note

If the TEST INSTRUMENT has been turned on, press the [RECALL] *and* [9] *keys in this order for initializing it at power-ON.*

Step	Procedure
3	Set the NETWORK ANALYZER as follows: START FREQUENCY .... 10 MHz STOP FREQUENCY ..... 300 MHz
4	Remove the cable connected to the DEVICE UNDER TEST terminal of the REFLECTION BRIDGE.
5	Press the [X → S] key of the NETWORK ANALYZER, and wait until completion of one sweep measurement.
6	Turn on the X-S lamp of the NETWORK ANALYZER.
7	Connect the DEVICE UNDER TEST terminal of the REFLECTION BRIDGE to the INPUT-R or INPUT-T terminal of the TEST INSTRUMENT.
8	Read the maximum value on the NETWORK ANALYZER screen as a return loss of receiver input, while changing the INPUT RANGE of the TEST INSTRUMENT.

5.4.11 Crosstalk

Crosstalk between INPUT-R and INPUT-T channels is to measure the MAGNITUDE when the synthesizer output is input to INPUT-R on the TEST INSTRUMENT itself.

(1) Specifications

100 dB : Between INPUT-R and INPUT-T channels.

(2) Set-up

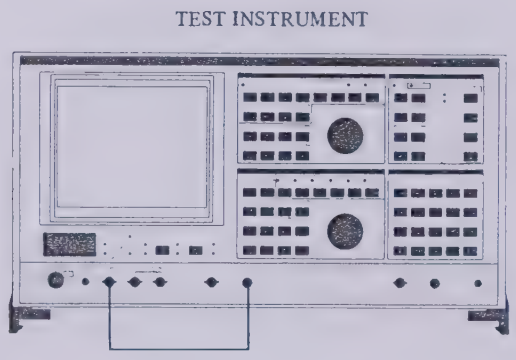


Fig. 5-12 Crosstalk

(3) Procedures

Step	Procedure
1	Set up the TEST INSTRUMENT as shown in Fig. 5-12.
2	Turn on the power of the TEST INSTRUMENT, and wait for at least 15 minutes.

Note

If the TEST INSTRUMENT has been turned on, press the [RECALL] *and* [9] *keys in this order for initializing it at power-ON.*

Step	Procedure

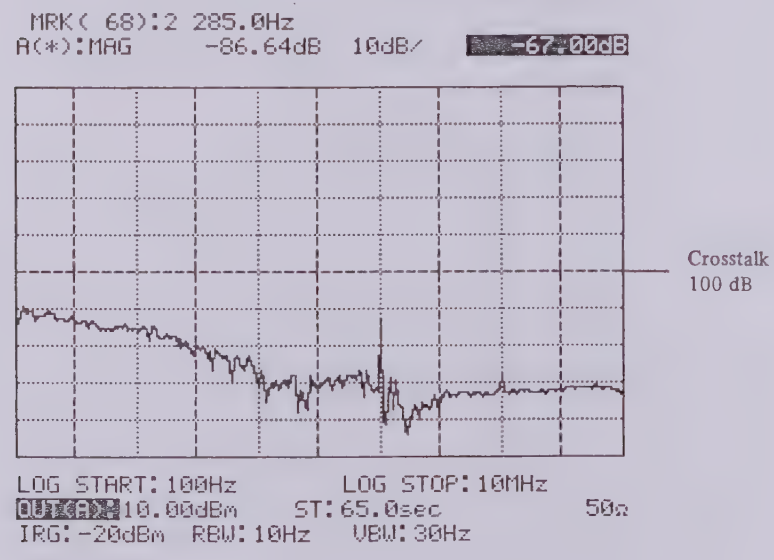
3 Set the TEST INSTRUMENT as follows:

LOG START ..... 100 Hz
LOG STOP ..... 10 MHz
RBW ..... 10 Hz
VBW ..... 30 Hz
OUTPUT ..... A
OUTPUT LEVEL ..... +10 dBm
INPUT RANGE ..... –20 dBm
OFFSET ..... –67 dB

4 Set the SWEEP TIME so that the UNCAL lamp does not light.

5 Press the [SINGLE START] key.

6 After completion of one sweep measurement, read the crosstalk referring to the following figure.



7 Set the TEST INSTRUMENT as follows, and measure the crosstalk according to steps 4 to 6.

LOG START ..... 10 MHz
LOG STOP ..... 300 MHz

5.4.12 Magnitude Accuracy

Magnitude accuracy is determined by measuring an attenuator.

(1) Specifications

±0.15 dB : 0 to −50 dB
±0.5 dB : −50 to −60 dB
±1.0 dB : −60 to −70 dB
±2.0 dB : −70 to −80 dB

(At 30 Hz of RBW, in a 3 to 300 MHz frequency range.)

(2) Set-up

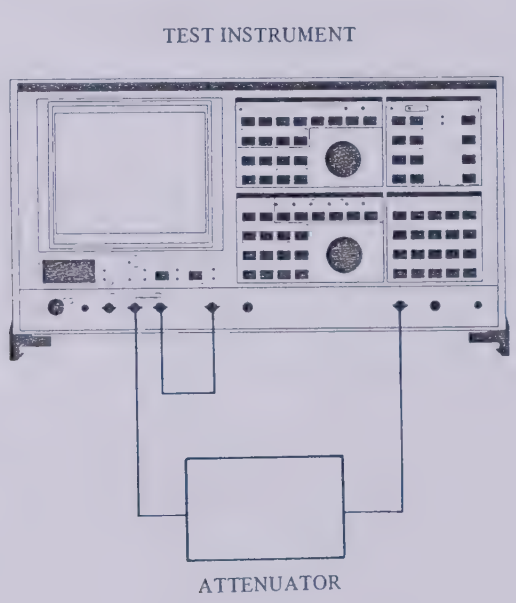


Fig. 5-13 Magnitude Accuracy

(3) Procedures

Step	Procedure
1	Set up the TEST INSTRUMENT and the ATTENUATOR as shown in Fig. 5-13.
2	Turn on the TEST INSTRUMENT and wait for at least 15 minutes.

Note

If the TEST INSTRUMENT has been turned on, press the [RECALL] *and* [9] *keys in this order for initializing it at power-ON.*

Step	Procedure
3	Set the TEST INSTRUMENT as follows: START ..... 3 MHz STOP ..... 300 MHz RBW ..... 30 Hz VBW ..... 100 Hz
4	Adjust the SWEEP TIME so that the UNCAL lamp does not light.
5	Press the [REPEAT START] key.
6	Set the ATTENUATOR to 0 dB.
7	Press the [X→S] key, and wait for completion of one sweep measurement.
8	Turn on the X-S lamp.
9	Set the ATTENUATOR to one of the attenuations shown below. [10 dB, 20 dB, 30 dB, 40 dB, 50 dB, 60 dB, 70 dB, 80 dB.]
10	Press the [RECALL] and [3] keys, in that order.
11	Read the magnitude on the screen at several frequencies by setting the MARKER.
12	For measuring all attenuations shown in step 9, repeat steps 9 to 11.

5.4.13 Phase Accuracy

Phase accuracy is evaluated by measuring a cable having linear-phase-shift frequency response.

(1) Specifications

±1 deg. at the some input level.

(2) Set-up

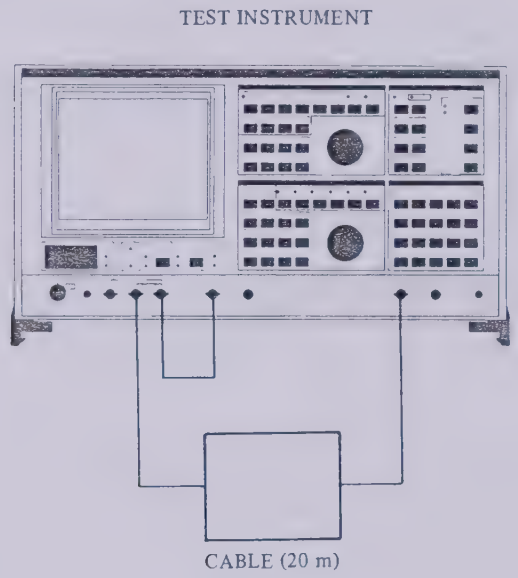


Fig. 5-14 Phase Accuracy

(3) Procedures

Step	Procedure
1	Set up the TEST INSTRUMENT and a 20 m length of cable, as shown in Fig. 5-14.
2	Turn on the TEST INSTRUMENT, and wait for at least 15 minutes.

Note

If the TEST INSTRUMENT has been turned on, press the [RECALL] *and* [9] *keys in this order for initializing it at power-ON.*

Step	Procedure

3 Set the TEST INSTRUMENT as follows:

TRACE ..... PHASE
START ..... 5 MHz
STOP ..... 30 MHz
RBW ..... 100 Hz
VBW ..... 300 Hz

4 Adjust the SWEEP TIME so that the UNCAL lamp does not light.

5 Connect OUTPUT-B and INPUT-T directly instead of the CABLE.

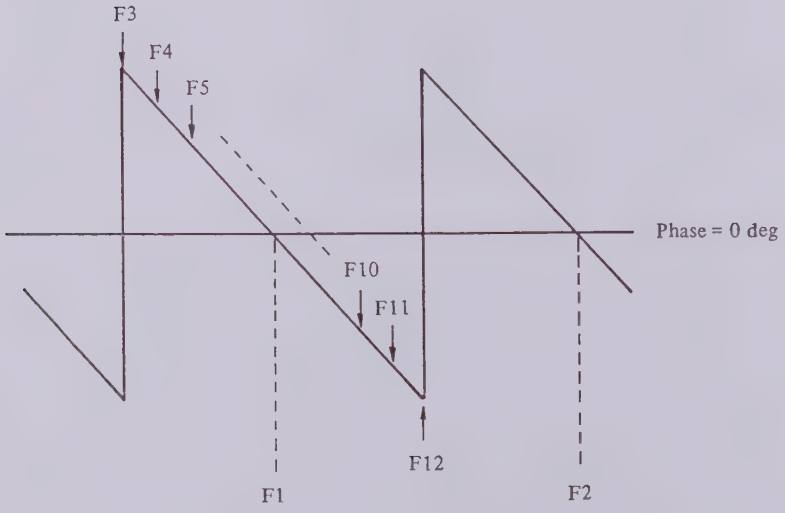
6 Press the [X → S] key, and wait for completion of one sweep measurement.

7 Turn on the X-S lamp.

8 Connect the CABLE to OUTPUT-B and INPUT-R.

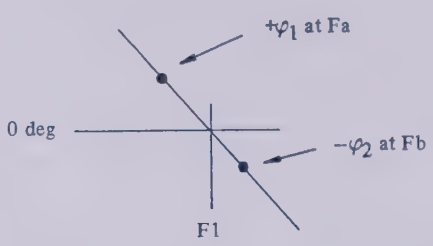
9 Press the [SINGLE START] key.

10 Determine the phase accuracy as described below, referring to the following figure.



Step	Procedure

11 Determine F_1 and F_2 as follows:



$$F_1 = \left(\frac{F_b - F_a}{\varphi_1 + \varphi_2}\right) \times \varphi_1 + F_a$$

12 Determine the ideal phase at all the frequencies — F_3, F_4, ... F_{12} — according to the following formula:

φ_5 at F_5

$$\varphi_5 = \frac{360}{F_2 - F_1} \cdot (F_1 - F_5)$$

13 Compare the measurement value and the ideal phase value at F_3 to F_{12}.

5.4.14 Level Characteristics of Phase Measurement

Level characteristics are the phase shifts when the input level is varied.

(1) Specifications

±1.5 deg : 0 to −50 dB
±3.0 deg : −50 to −70 dB
(At 30 Hz of RBW, and 3 to 300 MHz frequency range.)

(2) Set-up

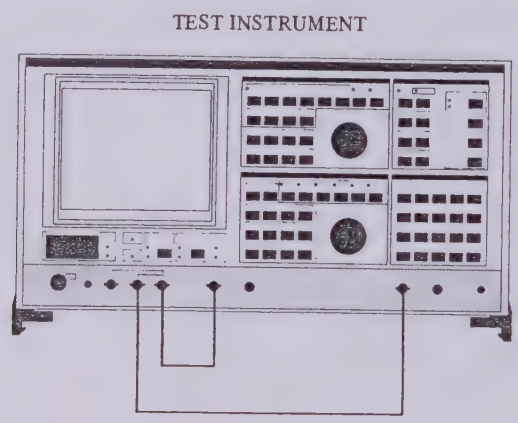


Fig. 5-15 Level Characteristics of Phase Measurement

(3) Procedures

Step	Procedure
1	Set up the TEST INSTRUMENT as shown in Fig. 5-15.
2	Turn on the TEST INSTRUMENT, and wait for at least 15 minutes.

Note

If the TEST INSTRUMENT has been turned on, press the [RECALL] *and* [9] *keys in that order for initializing it at power-ON.*

Step	Procedure
3	Set the TEST INSTRUMENT as follows: TRACE ..... PHASE START ..... 3 MHz STOP ..... 300 MHz RBW ..... 30 Hz VBW ..... 100 Hz SCALE ..... 1 deg/div
4	Adjust the SWEEP TIME so that the UNCAL lamp does not light.
5	Press the [REPEAT START] key.
6	Press the [X → S] key, and wait for completion of one sweep measurement.
7	Turn on the X-S lamp.
8	Measure the phase shift, varying the synthesizer output level between 0 dBm and −70 dBm in 10 dB steps.

5.4.15 Delay Accuracy

Delay accuracy is measured when input level is varied.

(1) Specifications

±0.5 % of range : 0 to −50 dB
±2 % of range : −50 to −70 dB
(At 30 Hz of RBW, and 3 to 300 MHz frequency range.)

(2) Set-up

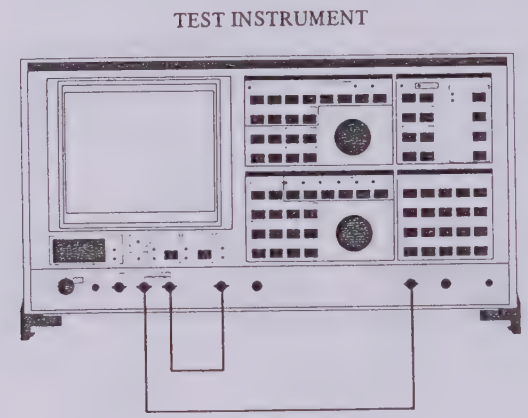


Fig. 5-16 Delay Accuracy

(3) Procedures

Step	Procedure
1	Set up the TEST INSTRUMENT as shown in Fig. 5-16.
2	Turn on the TEST INSTRUMENT, and wait for at least 15 minutes.

Note

If the TEST INSTRUMENT has been turned on, press the [RECALL] *and* [9] *keys in this order for initializing it at power-ON.*

Step	Procedure
3	Set the TEST INSTRUMENT as follows: TRACE ..... DELAY START ..... 3 MHz STOP ..... 300 MHz RBW ..... 30 Hz VBW ..... 100 Hz DELAY RANGE ..... 1 μs SCALE ..... 10 ns'/DIV
4	Adjust the SWEEP TIME so that the UNCAL lamp does not light.
5	Press the [REPEAT START] key.
6	Press the [X → S] key, and wait for completion of one sweep measurement.
7	Turn on the X-S lamp.
8	Measure the DELAY, varying the synthesizer output level between 0 dBm and −70 dBm in 10 dB steps.

5.4.16 Level Accuracy

Level accuracy is determined by the sum of linearity error and synthesizer level accuracy (verified in paragraph 5.4.2) after rejecting the detuning error.

Refer to paragraph 3.2.3, on how to make precision-level-measurements while rejecting the detuning error. Thus, this paragraph describes how to measure linearity errors.

(1) Specifications

Level accuracy:

±0.5 dB : +20 to –90 dBm
±1.0 dB : –90 to –100 dBm
±3.0 dB : –100 to –120 dBm

(At 30 Hz of RBW, and 3 to 300 MHz frequency range)

Linearity:

±0.15 dB : 0 to –50 dB
±1.0 dB : –50 to –60 dB
±3.0 dB : –60 to –70 dB

(At 30 Hz of RBW, and 3 to 300 MHz frequency range)

(2) Set-up

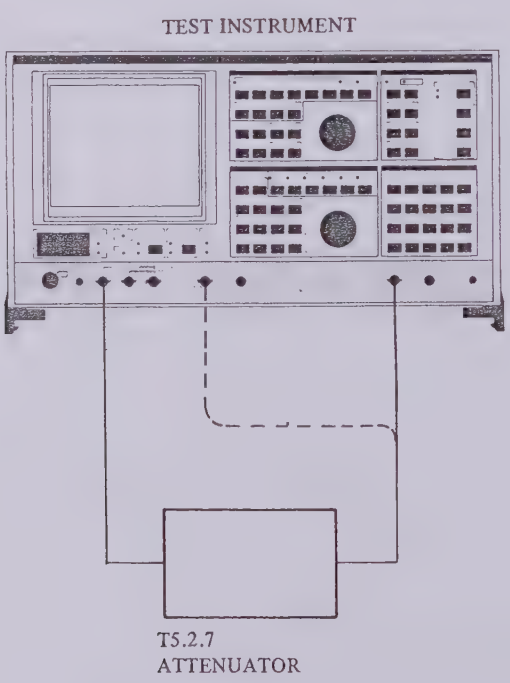


Fig. 5-18 Linearity

(3) Procedures

Step	Procedure
1	Set up the TEST INSTRUMENT as shown in Fig. 5-18.
2	Turn on the TEST INSTRUMENT, and wait for at least 15 minutes.
	Note
	If the TEST INSTRUMENT has been turned on, press the [RECALL] and [9] keys in this order for initializing it at power-ON.
3	Set the TEST INSTRUMENT as follows: TRACE ..... LEVEL (R) or LEVEL (T) START ..... 3 MHz STOP ..... 300 MHz RBW ..... 30 Hz VBW ..... 100 Hz
4	Press the [REPEAT START] key.
5	Adjust the SWEEP TIME so that the UNCAL lamp does not light.
6	Set the ATTENUATOR to 0 dB.
7	Press the [X→S] key, and wait for completion of one sweep measurement.
8	Turn on the X-S lamp.
9	Set the ATTENUATOR to one of the attenuations shown in the following Table. 10 dB, 20 dB, 30 dB, 40 dB, 50 dB, 60 dB, 70 dB.
10	Press the [RECALL] and [3] keys, in that order.
11	Read the level on the screen at several frequencies by setting the MARKER.
12	For measuring all the attenuations shown in step 9, repeat steps 9 to 11.

5.4.17 Image Rejection

Image rejection is a reception level response when the image frequency signal is applied.

(1) Specifications

70 dB

The image frequencies are expressed in the following formulae:

(a) The image frequency (f_{im}) due to first mixer:

$f_{im} = f_s + 1313.4$ MHz

where f_s : receiving frequency

(b) The image frequency (f_{im}) due to second mixer:

$f_{im} = f_s + 113.4$ MHz

(c) The image frequency (f_{im}) due to third mixer:

$f_{im} = f_s + 13.4$ MHz

(d) The image frequency (f_{im}) due to fourth mixer:

$f_{im} = f_s + 900$ kHz

(2) Set-up

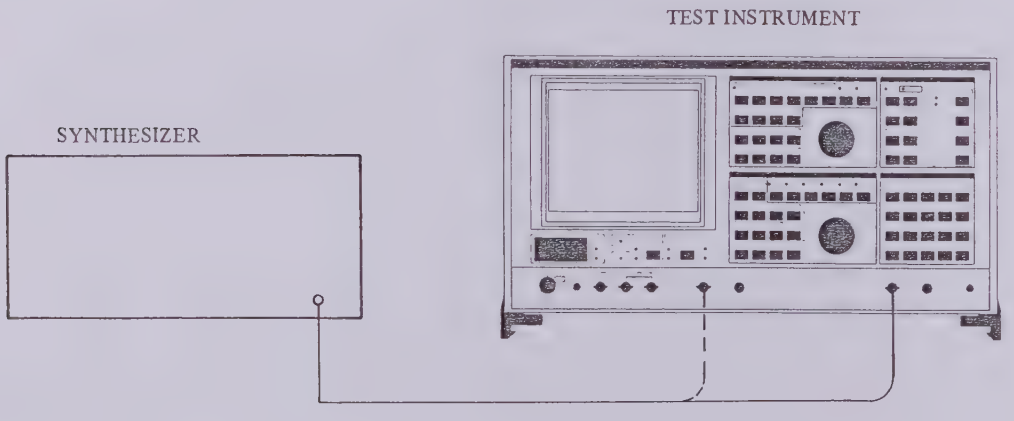


Fig. 5-19 Image Rejection

(3) PROCEDURES

Step	Procedure
1	Set up the TEST INSTRUMENT and the SYNTHESIZER as shown in Fig. 5-19.
2	Turn on the TEST INSTRUMENT, and wait for at least 15 minutes.
	Note *If the TEST INSTRUMENT has been turned on, press the* [RECALL] *and* [9] *keys in this order for initializing it at power-ON.*
3	Set the TEST INSTRUMENT as follows: TRACE ..... LEVEL (R) or LEVEL (T) CF ..... 10 MHz SPAN ..... 500 Hz RBW ..... 30 Hz VBW ..... 100 Hz
4	Adjust the SWEEP TIME so that the UNCAL lamp does not light.
5	Set the SYNTHESIZER to one of the frequencies in the following table, at 0 dBm output: 1323.4 MHz, 123.4 MHz, 23.4 MHz, 10.9 MHz.
6	Set the MARKER to the center on the SCREEN, and read the digital indication.
7	For measuring all the image frequencies shown in step 5, repeat steps 5 and 6.

5.4.18 IF Rejection

IF rejection is a reception level response when the IF frequency is applied, not tuning the receiving frequency to IF frequency.

(1) Specifications

70 dB

IF frequencies are as follows:

656.7 MHz, 56.7 MHz, 6.7 MHz, 450 kHz.

(2) Set-up

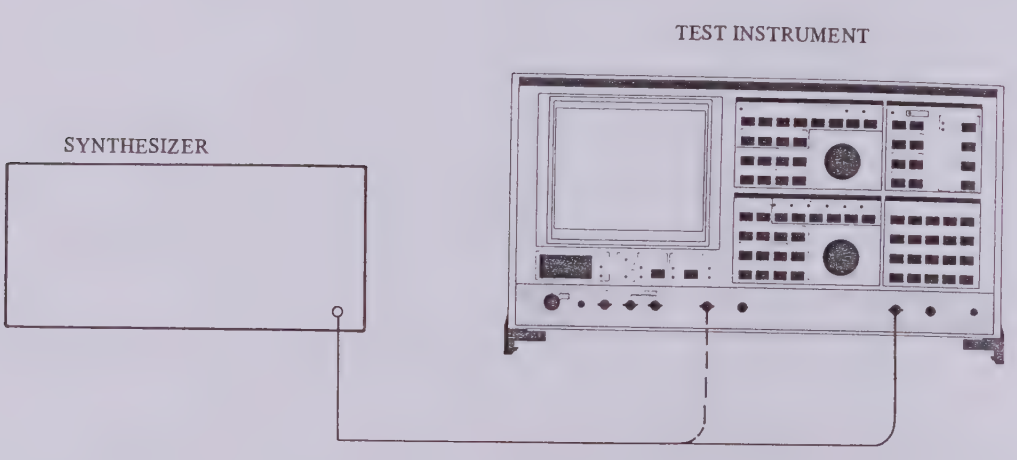


Fig. 5-20 IF Rejection

(3) Procedures

Step	Procedure
1	Set up the TEST INSTRUMENT and the SYNTHESIZER as shown in Fig. 5-20.
2	Turn on the TEST INSTRUMENT, and wait for at least 15 minutes.
	Note *If the TEST INSTRUMENT has been turned on, press the [RECALL] and [9] keys in this order for initializing it at power-ON.*

Step	Procedure
3	Set the TEST INSTRUMENT as follows: TRACE ..... LEVEL (R) or LEVEL (T) CF ..... 100 MHz SPAN ..... 500 Hz RBW ..... 30 Hz VBW ..... 100 Hz
4	Adjust the SWEEP TIME so that the UNCAL lamp does not light.
5	Press the [REPEAT START] key.
6	Set the SYNTHESIZER to one of the following frequencies, at 0 dBm output: 656.7 MHz, 56.7 MHz, 6.7 MHz, 450 kHz.
7	Set the MARKER to the center on the SCREEN, and read the digital indication.
8	For measuring all the IF frequencies shown in step 6, repeat steps 6 and 7.

5.4.19 Internal Distortion

Internal distortion is a level response at harmonic frequencies when receiving a no-harmonic distortion signal.

(1) Specifications

–50 dB at 100 Hz to 3 MHz and RBW ≦ 300 Hz
–60 dB at 3 to 150 MHz

(2) Set-up

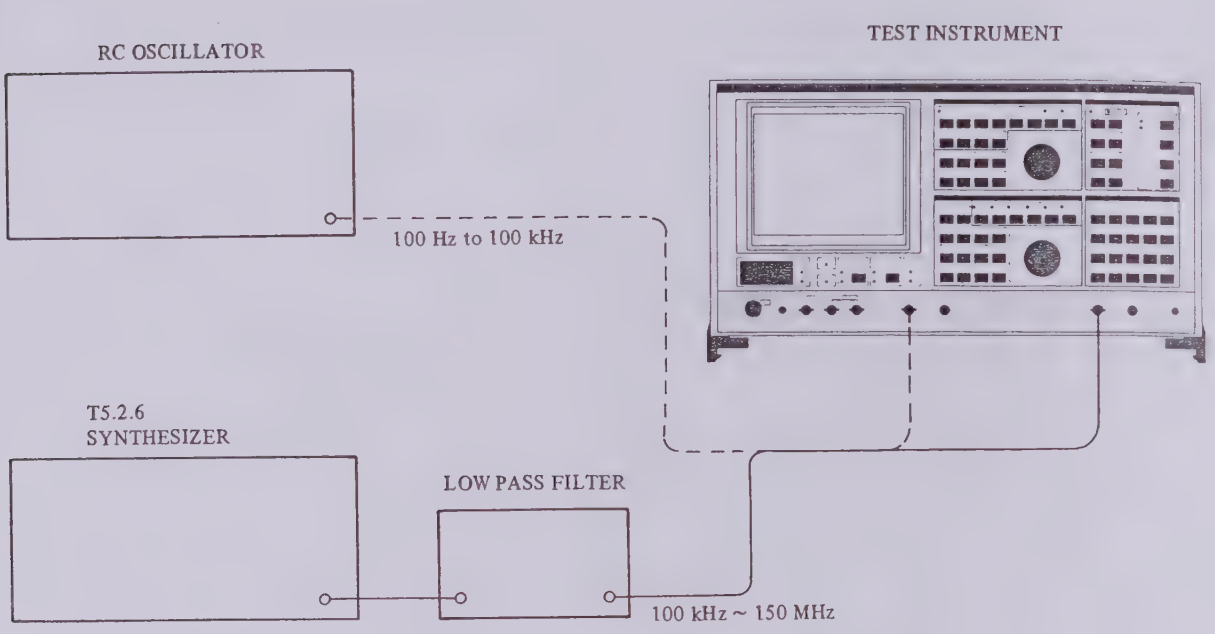


Fig. 5-21 Internal Distortion

(3) Procedures

Step	Procedure
1	Set up the TEST INSTRUMENT and the RC OSCILLATOR or the SYNTHESIZER; along with the LOW PASS FILTER, as shown in Fig. 5-21.

Note

The RC OSCILLATOR is used for a 100 Hz to 100 kHz signal output, and the SYNTHESIZER and the LOW PASS FILTER are used for a 100 kHz to 150 MHz signal output.

Step	Procedure

2 Turn on the TEST INSTRUMENT, and wait for at least 15 minutes.

Note

If the TEST INSTRUMENT has been turned on, press the [RECALL] and [9] keys in this order for initializing it at power-ON.

3 Set the TEST INSTRUMENT as follows:

TRACE ..... SPECT (R) or SPECT (T)

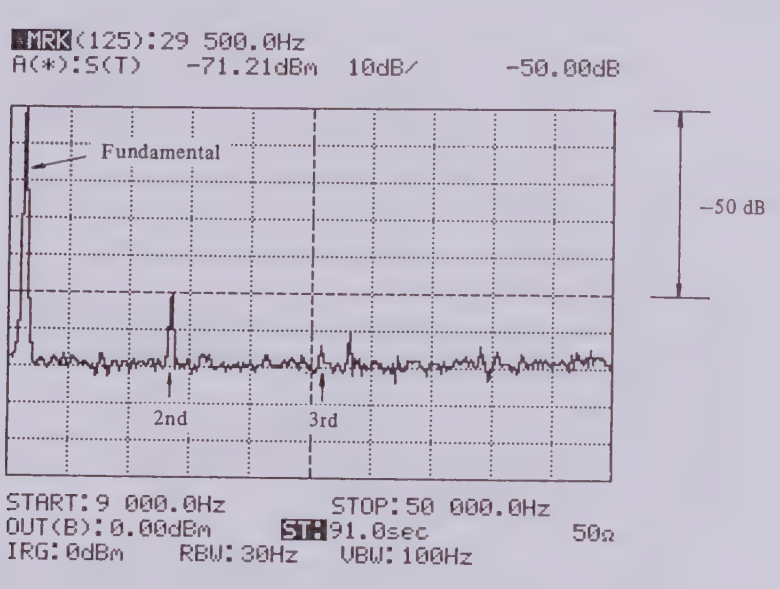
4 Set the SYNTHESIZER or the RC OSCILLATOR frequency to (1) F1 as shown in the following table. Finally, set the TEST INSTRUMENT as follows:

START ..... (2) START
STOP ..... (3) STOP
RBW ..... (4) RBW
VBW ..... (5) VBW

(1) F1	(2) START	(3) STOP	(4) RBW	(5) VBW
100 Hz	100 Hz	500 Hz	10 Hz	30 Hz
10 kHz	9 kHz	50 kHz	30 Hz	100 Hz
100 kHz	90 kHz	500 kHz	100 Hz	300 Hz
1 MHz	900 kHz	5 MHz	300 Hz	1 kHz
10 MHz	9 MHz	50 MHz	1 kHz	3 kHz
50 MHz	40 MHz	500 MHz	1 kHz	3 kHz
100 MHz	90 MHz	300 MHz	1 kHz	3 kHz
150 MHz	100 MHz	300 MHz	1 kHz	3 kHz

5 Press the [SINGLE START] key.

Step	Procedure
6	Determine the internal distortion from the SCREEN, referring to the following figure:



5.4.20 Spurious of Receiver

Spurious is measured by receiving a pure single tone signal.

(1) Specifications

−60 dB

(2) Set-up

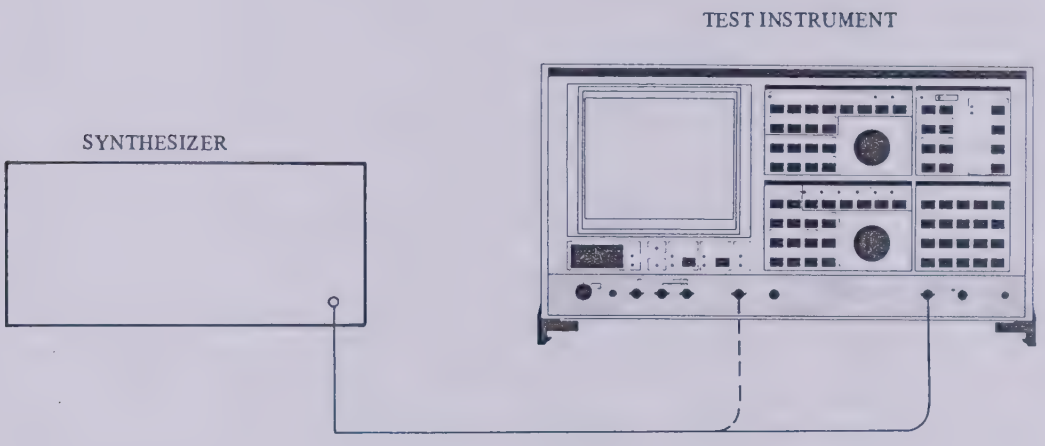


Fig. 5-22 Spurious of Receiver

(3) Procedures

Step	Procedure
1	Set up the TEST INSTRUMENT and the SYNTHESIZER as shown in Fig. 5-22.
2	Turn on the TEST INSTRUMENT, and wait for at least 15 minutes.
	Note *If the TEST INSTRUMENT has been turned on, press the* [RECALL] *and* [9] *keys in that order for initializing it at power-ON.*
3	Set the SYNTHESIZER to a 250 MHz frequency and a 0 dBm output.

Step	Procedure

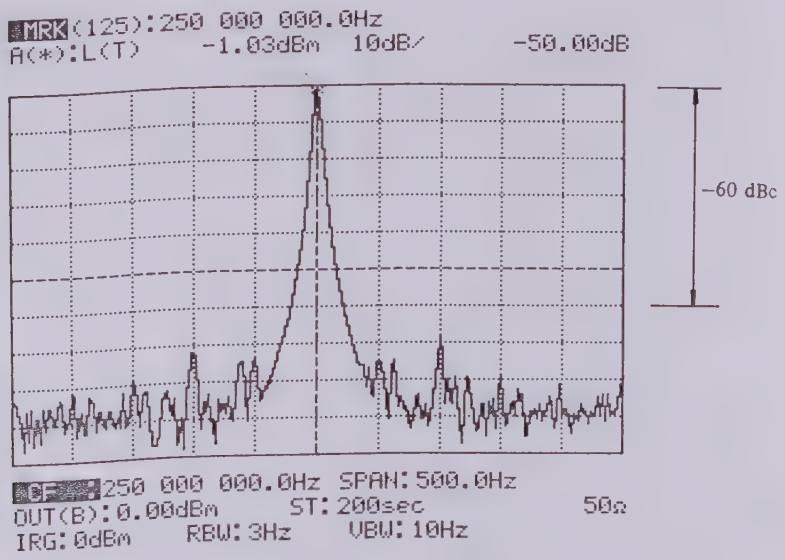
4 Set the TEST INSTRUMENT as follows:

TRACE ..... LEVEL (R) or LEVEL (T)
CF ..... 250 MHz
SPAN ..... 500 Hz
RBW ..... 3 Hz
VBW ..... 10 Hz

5 Adjust SWEEP TIME so that the UNCAL lamp does not light.

6 Press the [SINGLE START] key.

7 Determine the spurious from the SCREEN, referring to the following figure.



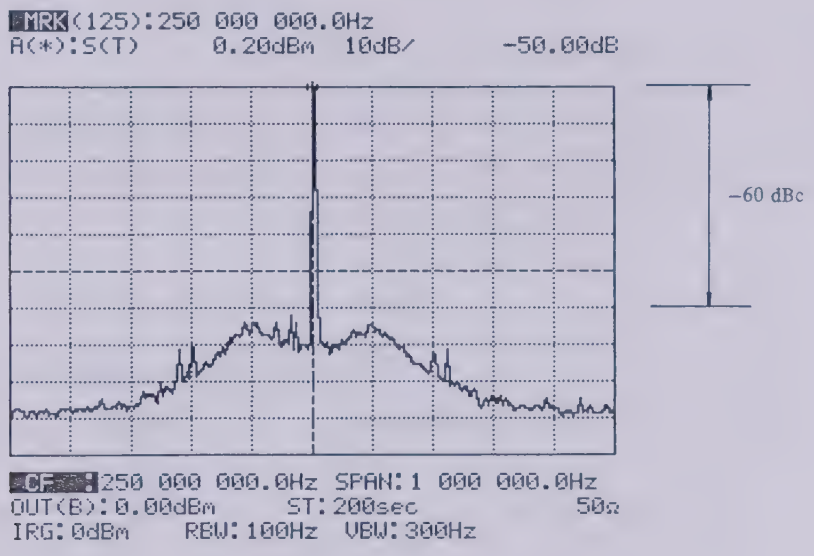
8 Set the TEST INSTRUMENT as follows:

TRACE ..... SPECT (R) or SPECT (T)
SPAN ..... 1 MHz
RBW ..... 100 Hz
VBW ..... 300 Hz

9 Adjust the SWEEP TIME so that the UNCAL lamp does not light.

10 Press the [SINGLE START] key.

Step	Procedure
11	Determine the spurious from the SCREEN, referring to the following figure.



5.4.21 Frequency Count Accuracy

Accuracy is determined by receiving a known frequency signal. Reference oscillator accuracy is tested in paragraph 5.4.1.

(1) Specifications

$\pm(5 \times 10^{-8} + 2\ Hz)$/day after 15 minutes warm-up at 23 ±5°C
$\pm(1 \times 10^{-7} + 2\ Hz)$/year after 24 hours warm-up at 23 ±5°C
$\pm(1 \times 10^{-7} + 2\ Hz)$/(0 to 50°C) after 15 minutes warm-up

(Signal is 20 dB greater than other signals or noise in the filter skirts, and the marker is set to the maximum value of the signals.)

(2) Set-up

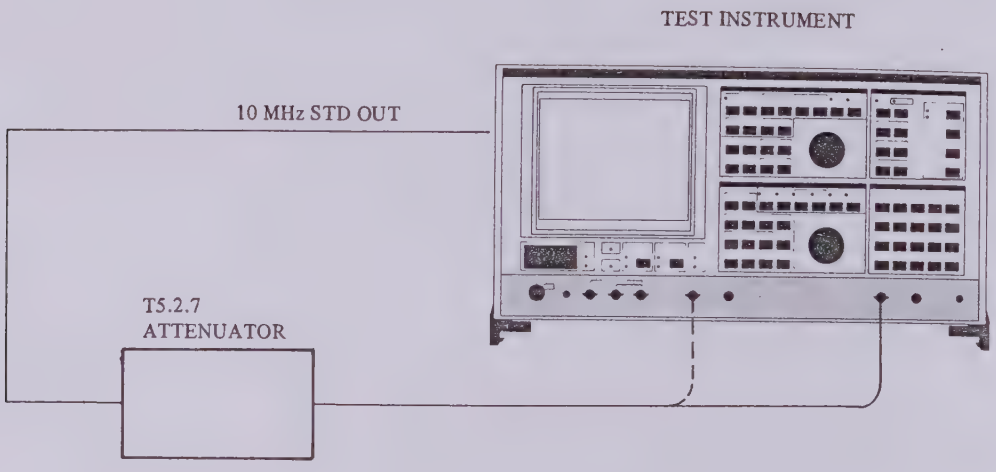


Fig. 5-23 Frequency Count Accuracy

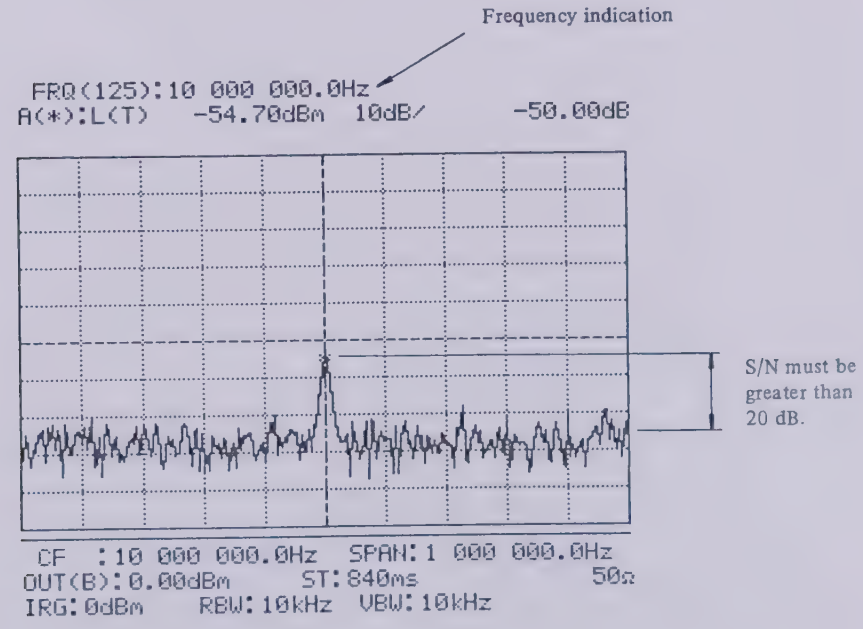
(3) Procedures

Step	Procedure
1	Set up the TEST INSTRUMENT and the ATTENUATOR as shown in Fig. 5-23.
2	Turn on the TEST INSTRUMENT, and wait for at least 15 minutes.

Note

If the TEST INSTRUMENT has been turned on, press the [RECALL] *and* [9] *keys in this order for initializing it at power-ON.*

Step	Procedure
3	Set the TEST INSTRUMENT as follows: TRACE ..... LEVEL (R) or LEVEL (T) CF ..... 10 MHz SPAN ..... 1 MHz RBW ..... 10 kHz
4	Press the [REPEAT START] key.
5	Adjust the SWEEP TIME so that the UNCAL lamp does not light.
6	Press the [BEGIN], [1], [3], and [EOL] keys, in that order.
7	Press the [O], [N], and [EOL] keys, in that order.
8	Press the [RETURN] key.
9	Adjust the ATTENUATOR so that the following picture appears on the SCREEN:



10	Read the FRQ value on the SCREEN, and confirm that it is within 10 MHz ±2 Hz.

TEST PERFORMANCE SHEET

The test performance sheets were drawn up after careful inpsection of your instrument.

Specification items other than the following were also checked and found to be correct.

DATE _____

TEST NO. _____

OPERATOR _____

TEMP _____

RELATIVE HUMIDITY _____

TESTED BY _____

ITEM 1 FREQUENCY ACCURACY OF SYNTHESIZER OUTPUT

SPECIFICATIONS

(a) $\pm 5 \times 10^{-8}$/day after 15 minutes warm-up at 23 ±5°C

(b) $\pm 1 \times 10^{-7}$/year after 24 hours warm-up at 23 +5°C

(c) $\pm 1 \times 10^{-7}$/0 to 50°C after 15 minutes warm-up.

RESULTS

- Frequency after 24-hours warm-up _____
- Frequency after 1 year warm-up _____
- Frequency at 0°C _____
- Frequency at 50°C _____

ITEM 2 LEVEL ACCURACY OF SYNTHESIZER OUTPUT

SPECIFICATIONS

±0.4 dB : –40 to +10 dBm
±1 dB : –80 to –40 dBm
(At OUTPUT-A)

RESULTS

- Level Accuracy at 0 dBm

100 Hz	10 kHz	1 MHz	10 MHz	100 MHz	200 MHz	300 MHz

- Step Error

0 dBm	0 dB	–50 dBm
–10 dBm		–60 dBm
–20 dBm		–70 dBm
–30 dBm		–80 dBm
–40 dBm		

ITEM 3 SIDEBAND PHASE NOISE OF SYNTHESIZER OUTPUT

SPECIFICATIONS

–85 dB/Hz at 10 kHz offset

RESULTS

1 MHz
10 MHz
100 MHz
200 MHz
300 MHz

ITEM 4 HARMONIC DISTORTION OF SYNTHESIZER OUTPUT

SPECIFICATIONS

−30 dB

RESULTS

	2nd	3rd
1 MHz		
10 MHz		
100 MHz		
200 MHz		
300 MHz		

ITEM 5 SPURIOUS OF SYNTHESIZER OUTPUT

SPECIFICATIONS

–55 dB or –100 dBm

RESULTS

Spurious Level _____

ITEM 6 IMPEDANCE OF SYNTHESIZER OUTPUT

SPECIFICATIONS

Return loss : 20 dB
(Output level is less than 0 dBm at OUTPUT-A terminal.)

RESULTS

Output Return Loss _____

ITEM 7 RESOLUTION BANDWIDTH OF RECEIVER

SPECIFICATIONS

3 dB bandwidth : 3 Hz to 30 kHz in 1, 3 sequences
Accuracy ±20 % at ≧30 Hz

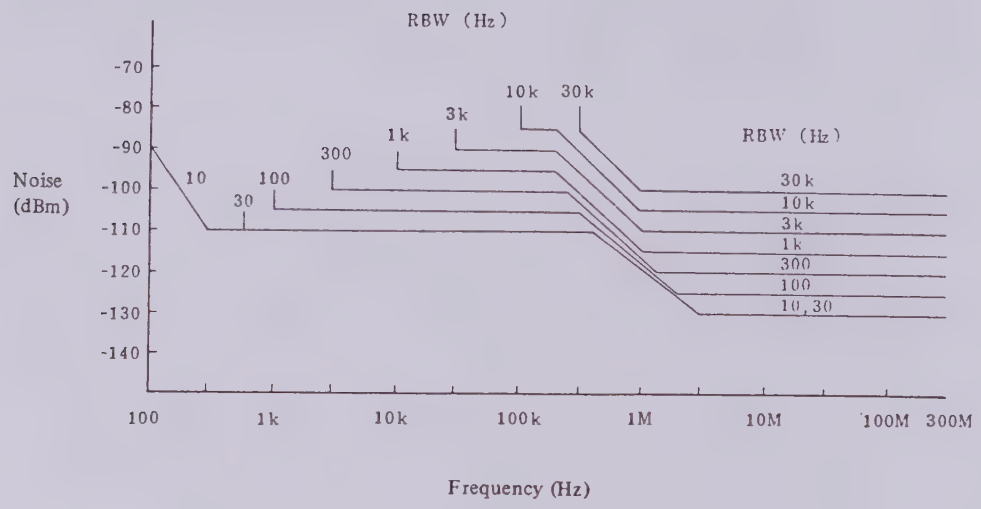
Selectivity : 20/1, shape factor 60 dB/3 dB

RESULTS

RBW	3 dB Bandwidth		Shape Factor	
	(R)	(T)	(R)	(T)
3 Hz				
10 Hz				
30 Hz				
100 Hz				
300 Hz				
1 kHz				
3 kHz				
10 kHz				
30 kHz				

ITEM 8 AVERAGE NOISE LEVEL OF RECEIVER

SPECIFICATIONS



RESULTS (R, T)

Frequency	10 Hz-RBW	300 Hz-RBW	3k-RBW	30k-RBW
10 Hz				
3 kHz				
30 kHz				
300 kHz				
3 MHz				
10 MHz				
100 MHz				
200 MHz				
300 MHz				

ITEM 9 RESIDUAL RESPONSE OF RECEIVER

SPECIFICATIONS

–60 dB or –100 dBm

RESULTS

	R	T		R	T
100 kHz			1 MHz		
2 MHz			10 MHz		
20 MHz			6.25 MHz		
12.5 MHz			18.75 MHz		
25 MHz			31.25 MHz		
50 MHz			100 MHz		
150 MHz			200 MHz		
250 MHz			300 MHz		
214.95 MHz			271.65 MHz		
124.4 MHz			162.2 MHz		
79.125 MHz			107.475 MHz		
229.125 MHz			257.475 MHz		
51.96 MHz					

ITEM 10 INPUT IMPEDANCE OF RECEIVER

SPECIFICATIONS

25 dB in return loss at greater than –10 dBm range.

RESULTS

IRG	R	T
+20 dBm		
+10 dBm		
0 dBm		
–10 dBm		
–20 dBm		
–30 dBm		
–40 dBm		

ITEM 11 CROSSTALK

SPECIFICATIONS

100 dB : Between INPUT-R and INPUT-T channels

RESULTS

Crosstalk _____

ITEM 12 MAGNITUDE ACCURACY

SPECIFICATIONS

±0.15 dB : 0 to –50 dB
±0.5 dB : –50 to –60 dB
±1.0 dB : –60 to –70 dB
±2.0 dB : –70 to –80 dB
(At 30 Hz of RBW, in a 3 to 300 MHz frequency range)

RESULTS

0 dB
–10 dB
–20 dB
–30 dB
–40 dB
–50 dB
–60 dB
–70 dB
–80 dB

ITEM 13 PHASE ACCURACY

SPECIFICATIONS

±1 deg at the same input level

RESULTS

Calculated Value	Error

ITEM 14 LEVEL CHARACTERISTICS OF PHASE MEASUREMENT

SPECIFICATIONS

±1.5 deg : 0 to –50 dB

±3.0 deg : –50 to –70 dB

(At 30 Hz of RBW, and 3 to 300 MHz frequency range)

RESULTS

0 dB	0 deg.
–10 dB	
–20 dB	
–30 dB	
–40 dB	
–50 dB	
–60 dB	
–70 dB	

ITEM 15 DELAY ACCURACY

SPECIFICATIONS

±0.5 % of range : 0 to –50 dB

±2 % of range : –50 to –70 dB

(At 30 Hz of RBW, and 3 to 300 MHz frequency range)

RESULTS

0 dB	0 ns
–10 dB	
–20 dB	
–30 dB	
–40 dB	
–50 dB	
–60 dB	
–70 dB	

ITEM 16 LEVEL ACCURACY

SPECIFICATIONS

Level accuracy

±0.5 dB : +20 to –90 dBm
±1.0 dB : –90 to –100 dBm
±3.0 dB : –100 to –120 dBm

(At 30 Hz of RBW, and 3 to 300 MHz frequency range)

Linearity

±0.15 dB : 0 to –50 dB
±1.0 dB : –50 to –60 dB
±3.0 dB : –60 to –70 dB

(At 30 Hz of RBW, and 3 to 300 MHz frequency range)

RESULTS

	Linearity Error (R)	Linearity Error (T)
0 dB	0 dB	0 dB
–10 dB		
–20 dB		
–30 dB		
–40 dB		
–50 dB		
–60 dB		
–70 dB		

ITEM 17 IMAGE REJECTION

SPECIFICATIONS

70 dB

RESULTS

	(R)	(T)
f_S + 1313.4 MHz		
f_S + 113.4 MHz		
f_S + 13.4 MHz		
f_S + 900 kHz		

ITEM 18 IF REJECTION

SPECIFICATIONS

70 dB

RESULTS

	(R)	(T)
656.7 MHz		
56.7 MHz		
6.7 MHz		
450 kHz		

ITEM 19 INTERNAL DISTORTION

SPECIFICATIONS

–50 dB at 100 Hz to 3 MHz and RBW ≦ 300 Hz

–60 dB at 3 to 150 MHz

RESULTS

	(R)	(T)
100 Hz		
10 kHz		
100 kHz		
1 MHz		
10 MHz		
50 MHz		
100 MHz		
150 MHz		

ITEM 20 SPURIOUS OF RECEIVER

SPECIFICATIONS

–60 dB

RESULTS

Spurious at 500 Hz SPAN _____

Spurious at 1 MHz SPAN _____

ITEM 21 FREQUENCY COUNT ACCURACY

SPECIFICATIONS

$\pm(5 \times 10^{-8} + 2\ Hz)$/day after 15 minutes warm-up

$\pm(1 \times 10^{-7} + 2\ Hz)$/year after 24-hours warm-up

$\pm(1 \times 10^{-7} + 2\ Hz)$/0 to 50°C after 15 minutes warm-up

RESULTS

Frequency Count Function _____

SECTION 6 STORAGE

CONTENTS

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6.2 RECOMMENDED STORAGE CONDITIONS 6-1

SECTION 6 STORAGE

6.1 STORAGE, CAUTIONS

Attention should be paid to the items listed below when storing the instrument for an extended period of time.

(1) Always clean the instrument throughly before storage.

(2) Do not store the instrument in a place of high temperatre (55°C or more), high humidity (90 % or more), or excessive low temperature (–25°C or less).

(3) Do not store the instrument in direct sunlight or in a dusty place.

(4) Do not store the instrument in a place where it may be affected by condensation or corrosive gases.

6.2 RECOMMENDED STORAGE CONDITIONS

In addition to the conditions listed above, the following environmental conditions are recommended when storing the instrument for an extended period of time.

Temperature: 0 to 30°C
Humidity: 40 to 80 %

The place should not be subject to large changes in temperature and humidity during the day.

APPENDIX

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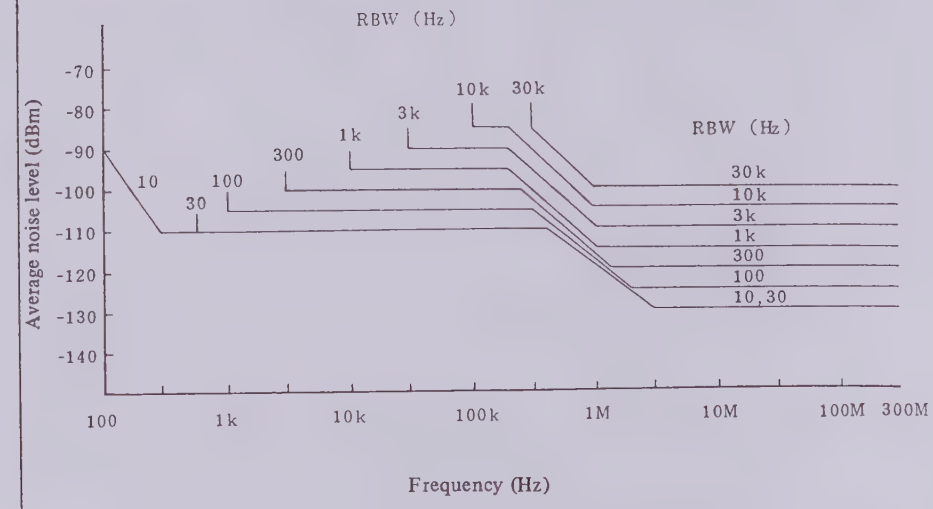
APPENDIX 1-(a) MS560J SPECIFICATIONS

Frequency range		100 Hz to 300 MHz
Measurement items		Magnitude, Phase, Delay, Level, Spectrum, Frequency, and Envelope display
Sampling points		251 points
Sweep time		500 mS* to 24 hours (*: Depends on the measurement item and measurement conditions.)
Impedance		50 Ω (Measurements in 75 Ω impedance are available when using the MA518A 75 Ω IMPEDANCE CONVERTER)
Synthesizer	Frequency	100 Hz to 300 MHz, 0.1 Hz steps
	Frequency Accuracy	±5 x 10^{-8}/day after a 15-minute warm up at 23 ±5°C ±1 x 10^{-7}/year after a 24-hour warm up at 23 ±5°C ±1 x 10^{-7}/0 to 50°C after a 15-minute warm up
	Level	–110 to +10 dBm (OUTPUT-A), 0.01 dB steps –110 to +4 dBm (OUTPUT-B), 0.01 dB steps
	Level accuracy	±0.4 dB : –40 to +10 dBm ±1 dB : –80 to –40 dBm (At OUTPUT-A)
	Sideband phase noise	–85 dB/Hz at 10 kHz offset
	Harmonic distortion	–30 dB
	Spurious	–55 dB or –100 dBm
	Connector	BNC
	Impedance	Return loss 20 dB: (output level less than 0 dBm at OUTPUT-A terminal)
Receiver	Frequency	100 Hz to 300 MHz
	Input terminals	R and T (2 channels)
	Input ranges	–40 to +20 dBm, 10 dB steps
	Maximum input	+24 dBm AC $^{+1.5}_{-3.5}$ V DC

APPENDIX 1-(a) MS560J SPECIFICATIONS

(Cont'd)

Receiver	Resolution bandwidth	3 Hz to 30 kHz in 1, 3 sequences Accuracy : ±20 % at ≧30 Hz Selectivity : 20/1, shape factor 60 dB/3 dB
	Video Bandwidth	3 Hz to 30 kHz in 1, 3 sequences
	Average noise level	
	Residual response	–60 dB or –100 dBm
	Connector	BNC
	Impedance	Return loss : 25 dB in greater than –10 dBm range
	Crosstalk	100 dB : Between R and T channels
Magnitude	Frequency	100 Hz to 300 MHz
	Range	±100 dB
	Resolution	0.01 dB
	Accuracy	±0.15 dB : 0 to –50 dB ±0.5 dB : –50 to –60 dB ±1 dB : –60 to –70 dB ±2 dB : –70 to –80 dB (At 30 Hz of RBW, and 3 to 300 MHz frequency range)

Phase	Frequency	100 Hz to 300 MHz
	Range	±180 deg
	Resolution	0.1 deg
	Accuracy	±1 deg at the same input level
	Level characteristics	±1.5 deg : 0 to −50 dB ±3 deg : −50 to −70 dB (At 30 Hz of RBW, and 3 to 300 MHz frequency range)
Delay	Frequency	100 Hz to 300 MHz
	Range	100 ns to 40 ms 17 ranges in 1, 2, 4 sequences
	Resolution	Normal : 1/1000 of range Expand : 1/10000 of range
	Accuracy	±0.5 % : 0 to −50 dB ±2 % : −50 to −70 dB (At 30 Hz of RBW, and 3 to 300 MHz frequency range)
Level	Frequency	100 Hz to 300 MHz
	Range	−130 to +20 dBm
	Resolution	0.01 dB
	Accuracy	±0.5 dB : +20 to −90 dBm ±1.0 dB : −90 to −100 dBm ±3 dB : −100 to −120 dBm (At 30 Hz of RBW, and 3 to 300 MHz frequency range)
	Linearity	±0.15 dB : 0 to −50 dB ±1.0 dB : −50 to −60 dB ±3.0 dB : −60 to −70 dB (At 30 Hz of RBW, and 3 to 300 MHz frequency range)
Spectrum	Image rejection	70 dB
	IF rejection	70 dB
	Internal distortion	−50 dB at 100 Hz to 3 MHz and RBW $\leqq$ 300 Hz −60 dB at 3 to 150 MHz
	Spurious	−60 dB

APPENDIX 1-(a) MS560J SPECIFICATIONS

(Cont'd)

Frequency count	Frequency	100 Hz to 300 MHz
	Resolution	1 Hz
	Accuracy	$\pm(5 \times 10^{-8} + 2$ Hz)/day after a 15-minute warm up at 23 ±5°C $\pm(1 \times 10^{-7} + 2$ Hz)/year after a 24-hour warm up at 23 ±5°C $\pm(1 \times 10^{-7} + 2$ Hz)/0 to 50°C after a 15-minute warm up (At a signal 20 dB greater than other signals and noise in the filter skirts, and marker set at the maximum value of object signals)
Envelope display	Carrier frequency	100 Hz to 300 MHz
	Sweep time	100 mS to at least 100 sec.
	Envelope frequency	DC to 200 Hz (depends on RBW and VBW)
Sweep mode	Frequency	LIN: START/STOP, CENTER/SPAN LOG: START/STOP
	Level	START/STOP/STEP
Sweep range	AUTO	Automatic sweep over the full range
	MARKER	Measures only marker point or sweeps only the range between two markers.
Sweep control		RESET, STOP, REPEAT START, SINGLE START
Automatic setting		SIGNAL TRACK: Ganged to maximum received signal automatically
		BW, ST: COUPLED TO FREQ Resolution bandwidth, Video bandwidth and Sweep time are automatically set to the optimum value by ganging with span width
		BW, ST: COUPLED TO SPAN Resolution bandwidth, Video bandwidth and Sweep time are automatically set to the optimum value by ganging with span width
Calibration	INT	Non-linearity error correction
	X→S	Offset error correction

Calculation	X – S	Automatic correction of offset error
	A – B	Arithmetic processing between A and B memories
	Δ	Deviation between MAIN marker and Δ marker
	ZERO	Deviation from reference value
Display	Display	6.5 inch FPD
	Trace	Same as the measuring items (rectangular coordinates)
	Sub-trace	Same as the measuring items (rectangular coordinates) B, A, A – B. It is not performed for Magnitude/Phase and Magnitude/Delay
	Marker	2 (MAIN marker and Δ marker)
	Character	Marker point data, Trace condition, Measurement condition
Function memory		3 (Trace condition, Measurement condition)
Rear panel INPUT/OUTPUT	Video output	75 Ω load, Approx. 1 Vp-p (BNC)
	10 MHz reference output	TTL level (BNC)
	56.7 MHz IF Out 450 kHz IF Out Det out	
	X → S switching signal	Open collector (36 pins)
	GP-IB	Compatible with IEEE488 (24 pins)
Remote control		GP-IB (IEEE488, IEC 625-1, 24 pins) SH1, AH1, T6, L4, SR1, RL1, PP0, DC0, DT0, C28 All functions (without power and intensity) of front panel are remotely controllable
Power		** Vac ±10 %, 50/60 Hz, <450 VA
Ambient temperature rated range of use		0°C to 50°C
Dimensions and weight		221.5 H, 426 W, 451 D mm, ≦ 35 kg

APPENDIX 1-(b) GP-IB Connection

Pin No.	Connection	
1	DIO 1	Data bus
2	DIO 2	
3	DIO 3	
4	DIO 4	
5	EOI	Interface control bus
6	DAV	Data byte transfer control bus
7	NRFD	
8	NDAC	
9	IFC	Interface control bus
10	SRQ	
11	ATN	
12	SHIELD	
13	DIO 5	Data bus
14	DIO 6	
15	DIO 7	
16	DIO 8	
17	REN	Interface control bus
18 – 24	GND	

APPENDIX 1-(c) I/O PORT CONNECTION

Pin No.	Connection	
1	GND	Control signal
2	NSTART	
3	NMEAS	
4	NRUNS	
5	NDOA0	Output port A
6	1	
7	2	
8	3	
9	4	
10	5	
11	6	
12	7	
13	NDOB0	Output port B
14	1	
15	2	
16	3	
17	4	
18	5	
19	6	
20	7	
21	NDIOC0	Output port C
22	1	
23	2	
24	3	
25	NDIOD0	Output port D
26	1	
27	2	
28	3	
29	NRDC	Status signal of port
30	NRDD	
31	NWTS	
32	NC	Nonconnected
33	NC	
34	+5V	+5 V, 100 mA output
35	CAL	Switching signal, Open collector
36	+20V	+20 V, 100 mA output

APPENDIX 2-(a) PTA1 OPTION SPECIFICATIONS

Display	Number of display characters		42 characters x 21 lines = 882 characters
	Displayable characters		Upper and lower case characters, numerals, special symbols, and cursor (total: 96 characters)
	Character font		5 x 7 dot matrix
	Graphic		2 screens (High and Low intensity displays), each 255 x 217 dots
Keyboard	Character key		Upper and lower case letters, numerals, special symbols (total: 50 keys)
	Edit key		[DEL] [INS] [∧] [∨] [<] [>]
	Command key		[RUN] [STE] [EOL] [RES]
	Switch key		[S1] [S2]
Mem-ory	Program area		12k bytes
PTL	Command		Basic commands (8 types) and PBM control commands (3 types)
	Statement		Basic statements (15 types) and GP-IB statement (2 types)
	Function		Arithmetic functions (12 types), boolean functions (4 types), and system functions (8 types)
	System subroutine		Display subroutines (4 types), GP-IB subroutines (2 types), and buzzer subroutine.
	Variable		Numeric, string, and system variables
	Data type	Single-precision integer	1 byte: 0 to 255
		Double-precision integer	2 bytes: −32768 to +32767
		Single-precision real number	4 bytes: Number of effective digits is 7, and exponential range is 10^{-20} to 10^{18}
		Double-precision real number	8 bytes: Number of effective digits is 14, and exponential range is 10^{-14} to 10^{13}
		Character	Maximum: 128 bytes
		Bit	Maximum: 8 bits
	Interface		GP-IB and I/O port
PBM	Circuit system		Serial loop
	Storage capacity		8K bytes (User area is 7.5K bytes)
	Program file		Maximum: 30 programs

APPENDIX 2-(b) A LIST OF PTL FUNCTIONS

Item number	Item			Format
1.1	Command	Delete		DELETE [line number 1] [, [line number 2]]
1.2	Command	List		LIST [line number 1] [, [line number 2]]
				LISTG address, [line number 1] [, [line number 2]]
1.3	Command	Renumber		RENUM [new line number [, increment [, old line number]]]
1.4	Command	Execution start		RUN [start line number] [, suspension line number]
1.5	Command	Execution continue		CONT [suspension line number]
1.6	Command	Save		SAVE program name
1.7	Command	Load		LOAD program name
1.8	Command	Program name list		PLIST
2.1	Statements	Comment		REM ["comment"]
2.2	Statements	Array declaration		DIM variable name (array size) [, variable name (array size) . . .]
2.3	Statements	Substitution		[LET] variable = expression
2.4	Statements	Branch		GOTO line number
2.5	Statements	Branch to subroutines		GOSUB line number
2.6	Statements	Return from subroutines		RETURN
2.7	Statements	Decision		IF variable = variable (or constant) statement
2.8	Statements	Repetition start		FOR numeric variable = initial value TO ending value [STEP increment]
2.9	Statements	Repetition termination		NEXT numeric variable
2.10	Statements	Key input		INPUT variable [format] [, variable [format] . . .]
2.11	Statements	Display		PRINT variable [format] [, variable [format] . . .] [;]
2.12	Statements	Home position		HOME
2.13	Statements	Erase		ERASE
2.14	Statements	Wait		WAIT constant
2.15	Statements	GP-IB input		READ address, variable [format] [, variable [format] . . .]
2.16	Statements	GP-IB output		WRITE address, variable [format] [, variable [format] . . .] [;]
2.17	Statements	System subroutine execution		CALL system subroutine name [(parameter (, parameter . . .))]
3.1	System subroutines	Screen clear		CRTC (N)
3.2	System subroutines	Screen return		CRTR (N)
3.4	System subroutines	Character string display		CRTC (X, Y, string, N)
3.5	System subroutines	Graphics display		CRTG (X0, Y0, X1, Y1, N)
3.6	System subroutines	IFC		IFC
3.7	System subroutines	SRQ output		RSV
3.8	System subroutines	Address modification		ADR (N)
3.9	System subroutines	Buzzer		BZR
4.1	Functions	Arithmetic functions		SIN, COS, TAN, ASN, ACS, ATN, LN, LOG, EXP, SQR, ABS, SGN
4.2	Functions	Boolean functions		NOT, AND, OR, NOR
4.3	Functions	System functions	Maximum value	MAX (maximum value point, starting point, terminating point, memory area)
			Minimum value	MIN (minimum value point, starting point, terminating point, memory area)
			Cut frequency 1	BNDL (designated measured-value point, search start point, designated measured-value, memory area)
			Cut frequency 2	BNDH (designated measured-value point, search start point, designated measured-value, memory area)
			Ripple 1	RPL1 (starting point, terminating point, memory area)
			Ripple 2	RPL2 (inflection point number, starting point, terminating point, memory area)
			Pole 1	POLL (low range pole point, starting point, designated attenuation, memory area)
			Pole 2	POLH (high range pole point, starting point, designated attenuation, memory area)

APPENDIX 3 ACCESSORIES (Option)

Order No.	Name	Remarks
34Y73726D	Panel cover	Front and rear panel covers
34Y73731D	Front handle kit	Handle 2
34Y73732D	Rack mount kit	Handle ..... 2 Angle 2

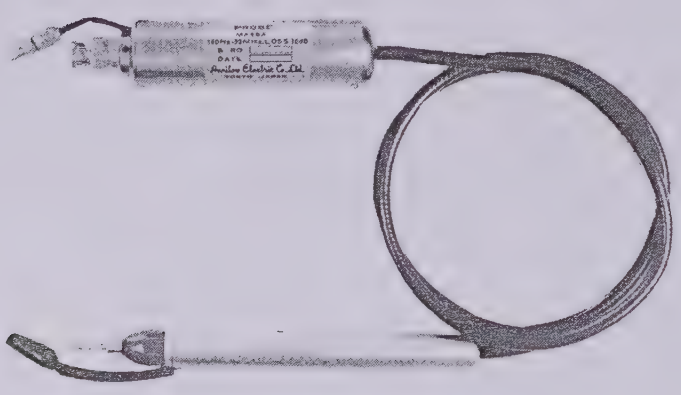
APPENDIX 4 TRANSFORMER

The transformers can be used to measure the magnitude, phase, delay, level, and spectrum of devices having balanced input and output impedances.

Model	Impedance		Frequency range
	Input	Output	
MA29A	75	600	30 Hz to 150 kHz
MA29J	50	600	30 Hz to 150 kHz
MA313A	75	75	4 kHz to 2 MHz
MA313J	50	75	4 kHz to 2 MHz
MA314A	75	135	4 kHz to 2 MHz
MA314J	50	135	4 kHz to 2 MHz
MA315A	75	150	4 kHz to 2 MHz
MA315J	50	150	4 kHz to 2 MHz

- Input connector is a BNC type in an unbalanced circuit.
- Output connectors are terminals compatible with M-214.
- Frequency response : <0.3 dB
- Return loss : >25 dB

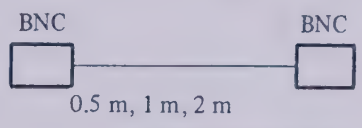
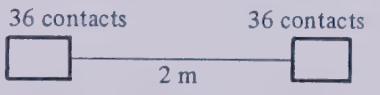
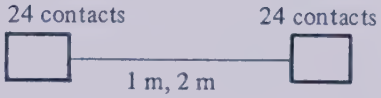
APPENDIX 5 AC PROBE (MA45A)



Specifications

Item	Specifications
Frequency	100 Hz to 30 MHz
Input level	2.74 Vrms MAX
Input capacitance	$\leqq$ 20 pF
Input impedance	$\geqq$ 3 MΩ
Loss	10 dB

APPENDIX 6 CABLE

Name	Detail
Coaxial cable	
I/O Port cable	
GP-IB cable	

APPENDIX 7 IMPEDANCE MEASURING KIT

Specifications of Reflection Bridges

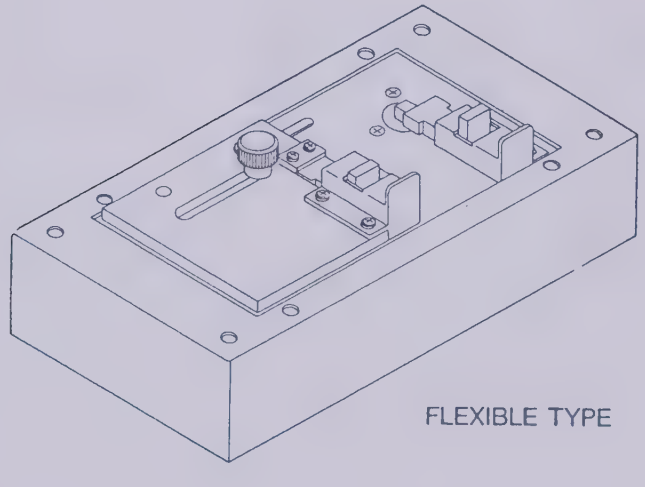
Item \ Model	MA412A	MA412J	MA27A
Impedance	75 Ω unbalanced	50 Ω unbalanced	600 Ω balanced
Connector	BNC	BNC	Terminal (compatible with M-214)
Frequency	10 Hz - 100 kHz 2 ranges 30 kHz - 30 MHz	10 Hz - 100 kHz 2 ranges 30 kHz - 30 MHz	10 Hz - 250 kHz
Directivity	>50 dB	>50 dB	>60 dB: 10 Hz - 150 kHz >40 dB: 150 - 250 kHz
Open/short	<0.5 dB, <5 deg	<0.5 dB, <5 deg	<0.5 dB, <5 deg
Standard termination	75 Ω, 0 Ω	50 Ω, 0 Ω	600 Ω, 0 Ω
Measurement cable	BNC-BNC, 10 cm	BNC-BNC, 10 cm	M-214-M-214, 10 cm
Dimensions and weight	54H, 53W, 141Dmm ≦0.9 kg	54H, 53W, 141Dmm ≦0.9 kg	66H, 53W, 149Dmm ≦0.8 kg

Item \ Model	MA312A	MA312B	MA312C
Impedance	75 Ω balanced	135 Ω balanced	150 Ω balanced
Connector	Terminal (compatible with M-214)	Terminal (compatible with M-214)	Terminal (compatible with M-214)
Frequency	2 kHz - 2 MHz	2 kHz - 2 MHz	2 kHz - 2 MHz
Directivity	>50 dB	>50 dB	>50 dB
Open/short	<0.5 dB, <5 deg	<0.5 dB, <5 deg	<0.5 dB, <5 deg
Standard termination	75 Ω, 0 Ω	135 Ω, 0 Ω	150 Ω, 0 Ω
Measurement cable	M-214-M-214, 10 cm	M-214-M-214, 10 cm	M-214-M-214, 10 cm
Dimensions and weight	66H, 53W, 149Dmm ≦0.8 kg	66H, 53W, 149Dmm ≦0.8 kg	66H, 53W, 149Dmm ≦0.8 kg

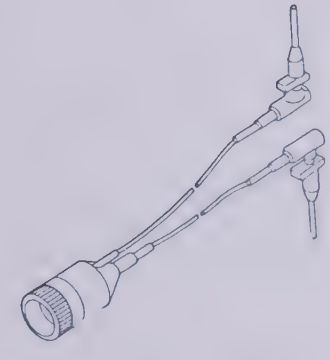
Specification of MA413A Impedance Probe

Item	Specification
Frequency range	30 kHz to 30 MHz
Impedance	1 Ω to 1 MΩ, ±180 deg.
Residual impedance	Resistance : <1.5 Ω (Typical value: 1 Ω) Inductance : <50 nH (Typical value: 35 nH) Capacitance : <0.3pF (Typical value: 0.15 pF)
DC cutoff	None
Standard resistance	100 Ω

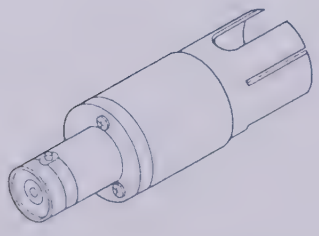
M414A Impedance Measurement Kit



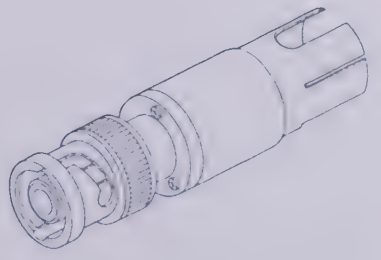
FLEXIBLE TYPE



CLIP TYPE

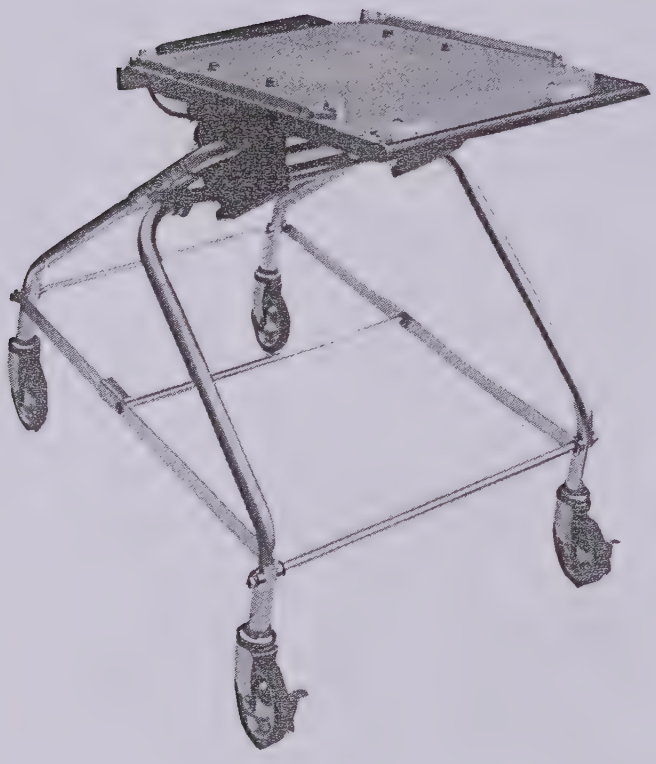


BNC RECEPTACLE TYPE



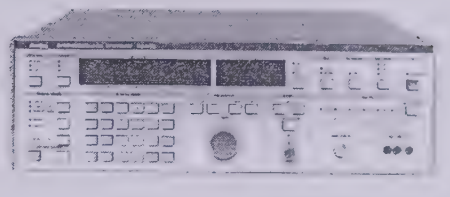
BNC JACK TYPE

APPENDIX 8 PORTABLE TEST RACK (MB23A)



APPENDIX 9 SYNTHESIZER

MG440A



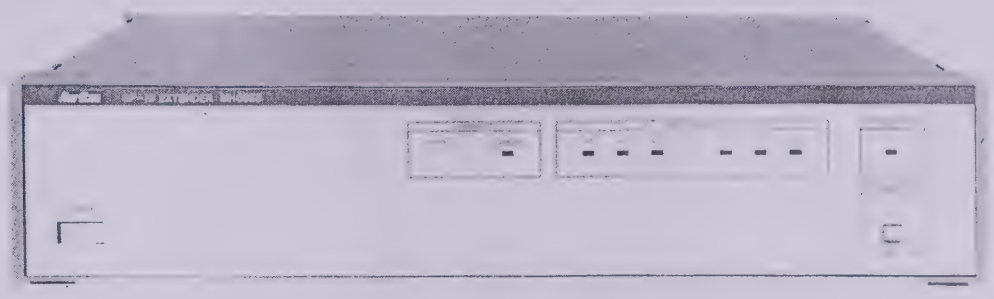
MG443B

Item	MG440A	MG443B	MG545[ ]
Frequency	10 Hz to 30 MHz 0.01 Hz resolution	10 Hz to 30 MHz 1 Hz resolution	10 KHz to 500 MHz 0.01 Hz resolution
Output level	−80 to +15 dBm Accuracy: ± 0.2 dB	−80 to +15 dBm Accuracy: ± 0.15 dB	−60 to +10 dBm Accuracy: ± 0.4 dB
Impedance Connector	75 Ω/50 Ω unbalanced BNC 150 Ω/600 Ω balanced I-214	75 Ω/50 Ω unbalanced BNC 75Ω/135 Ω/150 Ω/ 600 Ω balanced I-214	A type: 50Ω N K type: 75 Ω NC
GP-IB interface	Option	Standard	Option

APPENDIX 10 S PARAMETER TEST SET MH497A/J

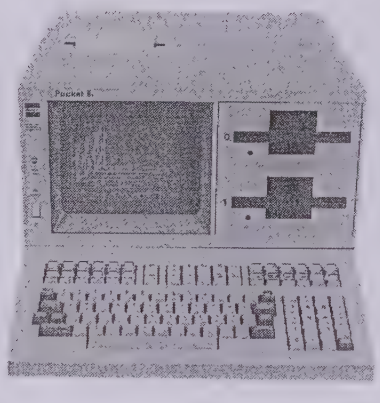
Item	Specifications
Impedance	type A: 75 Ω/600 Ω type J: 50 Ω/600 Ω
Frequency	75 Ω, 50 Ω unbalanced 10 Hz to 100 kHz 30 kHz to 30 MHz } 2 ranges 600 Ω balance 10 Hz to 150 kHz
Directivity	≧ 50 dB

APPENDIX 11 MH055B GP-IB EXTENDER



Item	Specifications
GP-IB interface transfer	GP-IB interface status can be sent to the opposite extender.
Serial interface	◦ Modem interface (JIS C 6361, RS232C) ◦ Current loop interface (20 mA) ◦ Internal modem (Option)
Communication system	• Full duplex ◦ Asynchronous
Communication speed	110, 300, 600, 1200, 2400, 4800, 9600 bit/s
Character format	◦ Start bit 1 ◦ Data bits 8 • Parity bit Even/odd/none ◦ Stop bit 1/2
Serial interface connector	DB-25P

APPENDIX 12 Packet IIe PERSONAL TECHNICAL COMPUTER



	Basic configuration
CPU	68000 (clock frequency of 8 MHz)
Memory size	ROM: 16KB RAM: 384KB (up to 2MB)
Memory unit	One mini-floppy disk drive Storage capacity: approx. 300KB Tracks: 80/disk Sector: 16/track Bytes/sector: 256 bytes
Display	9.5-inch CRT 64 characters x 29 lines, 5 x 7 dot matrix, alphanumeric characters, and symbols, Greek letters Graphic 512 x 348 dots, 4 screens
Clock/timer	One clock (year, month, day, hour, minute, and second) 8 timers
Tone generator	Frequency: 200 Hz to 15 kHz Duration: variable
Keyboard	ASCII keys, TEN key, Function keys, Editorial key, Command key, [or TEN key and Function key only]
Expantion slots	7 (2 for memory and 5 for interface or memory)
Operating temperature and humidity	5 to 45°C 20 to 80 % (no condensation)
Power	100/220 V*, 50/60 Hz, ≦ 200 VA
Dimensions and weight	280 H, 436 W, 650 Dmm, ≦ 28 kg

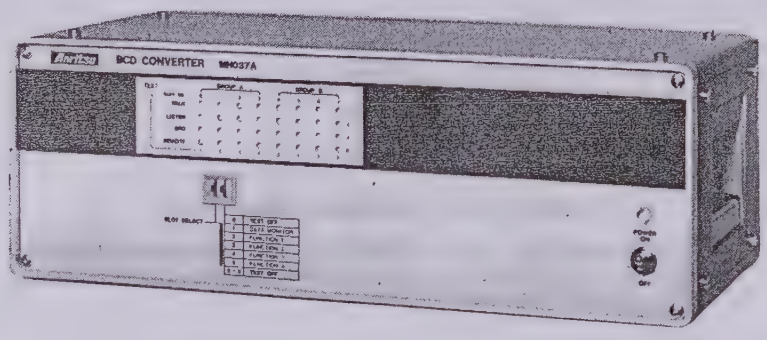
[ ]: Basic configuration with a simplified keyboard.

* Specify one nominal AC line voltage between 100 V and 250 V when ordering.

APPENDIX 12 Packet IIe PERSONAL TECHNICAL COMPUTER (Cont'd)

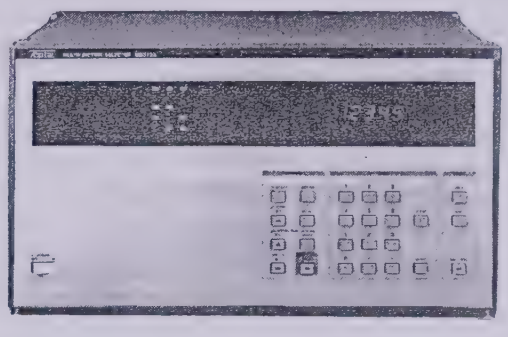
	Extender BASIC (Standard)
Effective digits	Decimal 12 digits
Dynamic range	$-9.99999999999 \times 10^{99} \sim -1 \times 10^{-99}, 0, 1 \times 10^{-99} \sim 9.99999999999 \times 10^{99}$
Types of numerical variables	Single, double, integer precision
Operators	+, –, *, /, ↑, =, <, >, &, AND, OR, NOT, XOR
Array dimensions	Up to 3 dimensions
Character string data length	255 characters
Characters handled	Alphanumerics (upper and lower case) symbols, numbers, Greek letters
Variable names	Numerical variables: Alphanumeric characters beginning with A to Z Character string variables: Alphanumeric characters beginning with A to Z and followd by a "$" Number of characters: Any
Statements	177 types ANS standard BASIC statements I/O statements GP-IB control statements Parallel processing statements Exceptional processing statements and others
Commands	31
Numeric supplied functions	37
Binary operation functions	11
Character string functions	20
Other functions	22

APPENDIX 13 MH037A BCD CONVERTER



Interface	GP-IB 2 types of primary addresses; 2 types of ONLY mode can be set. SH1, AH1, TE5, LE3, SR1, RL2, PP0, DC1, DT1, C0
Input/output slot	Up to 8 units in any combination can be mounted on the rear panel.
Conversion of BCD code apart from 0 to 9	Any ASCII Code (except C_R and L_F codes) can be set respectively at the primary addresses
SRQ Mask	Can be set for each unit.
Checking	Data monitor, switch displays, status displays, display of input unit data line, lamp test, test pattern and timing pulse transmission to the output unit.
Units	MH038A Parallel Input Unit: 32 bit TTL MH039A Parallel Output Unit: 32 bit TTL MH044A Parallel Input Unit: 20 bit photocoupler MH045A Parallel Output Unit: 16 bit relay contact

APPENDIX 14 MS010A MULTI FUNCTION SELECTOR



Item	Specifications
Slots for units	23 slots, multiple slots used according to the kind of unit
Interface	GP-IB SH1, AH1, T6, L4, SR1, RL1, PP0, CD1, DT0, C0
Channel combination setting	60
Collection data setting	60
Self-check function	SELF TEST key, executed when power turned on

Units

Model	Number of channels (connector)	Common channel (connector)	Frequency range	Impedance	Insertion loss	Return loss	Crosstalk attenuation	Passband noise
MH356A	6 (57-40500)	1 (HR10-10R-12S)	DC to 650kHz 650kHz to 2MHz	75Ω balanced	≦0.2dB	≧35dB	≧100dB ≧90dB	≦−120dBm
MH357A	6 (57-40500)	1 (HR10-10R-12S)	DC to 650kHz 650kHz to 2MHz	110Ω balanced	≦0.2dB	≧35dB	≧100dB ≧90dB	≦−120dBm
MH358A	6 (57-40500)	1 (HR10-10R-12S)	DC to 650kHz 650kHz to 2MHz	135Ω balanced	≦0.2dB	≧35dB	≧100dB ≧90dB	≦−120dBm
MH359A	6 (57-40500)	1 (HR10-10R-12S)	DC to 650kHz 650kHz to 2MHz	150Ω balanced	≦0.2dB	≧35dB	≧100dB ≧100dB	≦−120dBm
MH220A	6 (57-40500)	1 (HR10-10R-12S)	DC to 150kHz	600Ω balanced	≦0.2dB	≧35dB	≧115dB	≦−120dBm
MH483A	6 (BNC)	1 (BNC)	DC to 10MHz	75Ω unbalanced	≦0.2dB	≧30dB	≧80dB	≦−120dBm
MH494AB	6 (BNC) (SP2.5CPS)	1 (BNC) (SP2.5CPS)	DC to 13MHz 13 to 30MHz 30 to 100MHz	75Ω unbalanced	≦0.2dB ≦0.3dB ≦0.5dB	≧35dB ≧33dB ≧22dB	≧115dB ≧105dB ≧95dB	≦−120dBm
MH655A	4 (BNC)	4 (BNC)	DC to 100kHz 100 to 500MHz	50Ω unbalanced	≦0.2dB ≦0.5dB	≧25dB ≧22dB	≧90dB ≧80dB	≦−100dBm

APPENDIX 15 POLAROID CAMERA

Camera	Adaptor	Manufacturer	Remarks
197B	10378A	HP	Can be used by directly mounting it on the screen hood of the MS560J.
C-5C	016-0357-01	TEKTRONIX	
C-59 AP	016-0249-04	TEKTRONIX	
C-28	016-0249-04	TEKTRONIX	

APPENDIX 16 UA-455A VIDEO PLOTTER

Printing Specification

Printing method	Multi-head type heat-sensitive printing
Max. no. of rasters printable	
Interlace scanning signal	640 rasters (1 raster: 1 dot)
Sequential scanning signal	320 rasters (1 raster: 2 dot)
Reduction mode	
Interlace scanning signal	1280 rasters (2 raster: 1 dot)
Sequential scanning signal	640 rasters (1 raster: 1 dot)
Printing density	
Horizontal direction (feed direction)	5.906 dot/mm
Vertical direction (width direction)	5.906 dot/mm
Picture size	81 x 108 mm (when effective number of rasters is 480)
Recording speed	Approx. 19s/picture (standard screen) (Recording speed depends upon head temperature)

Specification of Printing Paper (Heat-Sensitive Printing Paper)

Printing paper size	127mm x 40m long rolled paper
Authorized printing paper	TF-50KS-C (Jujo Paper Ltd.) TSP-F50 SHZ (Fuji Film) F 200U 7H (Mitsubishi Paper Mills, Ltd.) FH65BX-17 (Honshu Paper Co., Ltd.)
End mark:	An end mark (red line) will appear on the printing surface of the paper (lower side of the screen) when there is lm of paper remaining.

3. Input Signal Specification

Signal types	Composite and separate
Scanning method	Interlaced and noninterlaced
Sync range	Vertical: 10 to 40 ms (25 Hz to 100 Hz) Horizontal: 30 to 65 μs (15.3 kHz to 33.3 kHz)
Type	
Composite video signal	Positive white level Negative sync Signal level: 0.5 to 10 Vp-p
Separate video signal	Polarity: Positive or negative Video signal level: 0.5 to 10 Vp-p Sync signal level: TTL

4. Connectors

Composite video signal	BNC Connector
Separate video signal	8-Pin DIN connector

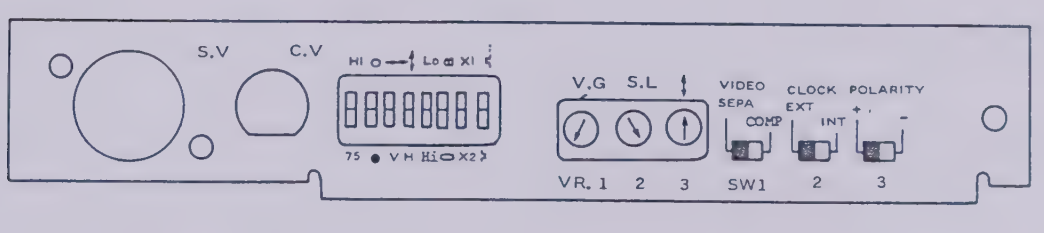
- **Setting up the UA-455A Video Plotter**

To make hard copies, connect the MS560J to a UA-455A video plotter, select a cable as described below, and set the switch and variable resistor on the rear panel of the UA-455A.

– Connection cable: DIN-8P cable (1 m)

Two types of connection cables, a DIN-8P cable (1 m) and BNC coaxial cable (2 m) come with the UA-455A as standard accessories.

– Switch and variable resistor setting



UA-455A Rear Panel

Note

1. *Set the switch to the black side in the above figure.*
2. *The variable resistor indicates the basic position. For fine tuning, refer to the UA-455A operation manual.*

Anritsu

OPERATION MANUAL

MS560J

PTA1 (OPTION 01)

ANRITSU CORP.

1985.10 x 60 NIII-4(Y)
Printed in Japan

CERTIFICATION

Anritsu Electric Co., Ltd. certifies that this instrument has been thoroughly tested and inspected, and found to meet published specifications prior to shipping.
Anritsu further certifies that its calibration measurements are based on the Japanese Electrotechnical Laboratory and Radio Research Laboratory standards.

WARRANTY

All Anritsu products are warranted against defects in material and workmanship. The warranty is effective for one year from the date of delivery. In the event of improper use, abuse, or damage due to natural catastrophe, the warranty will become void. Anritsu will repair or replace products which prove to be defective during the warranty period, provided they are returned to Anritsu.
No other warranty is expressed or implied.
All requests for repairs and replacement parts should be directed to Anritsu or its representative in your area.

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NOTICE

Anritsu changed its name from Anritsu Electric Co., Ltd. to ANRITSU CORP.
The new name is effective from October 1st 1985. Please change the old name to the new name in this manual.

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SECTION 1 GENERAL

Personal Test Automation 1 (abbreviated PTA hereinafter) is housed in the MS560J network/spectrum analyzer which is capable of operating as a personal computer so that high-speed calculations and control directly connected with the measurement system can be programmed with the high-level language PTL (Personal Test Language).

PTL consists of commands similar to those of BASIC, GP-IB control commands, PBM (Plug-in Bubble Memory) control commands, I/O port control commands, Network analysis commands, CRT control commands, and measurement commands to control the measurement functions of the MS560J.

Programs can be input and edited using the keys on the front panel of MS560J. It is also possible to input a program from a personal computer via GP-IB.

Since the PBM is nonvolatile, the stored application programs need not be reloaded after power has been turned off.

These application programs enable PTA to perform highspeed automatic checking and trimming of electronic parts.

Please refer to the MS560J Network/Spectrum Analyzer Operation Manual.

SECTION 2 COMPOSITION AND SPECIFICATIONS

2.1 Composition

Table 2-1 Composition

Item	Articles	Q'ty	Remarks
1	PTA package	1	
2	2K-byte RAM	7	
3	Operation Manual	1	
4	PBMI (Plug in Bubble Memory Interface)	1	Option 02
5	Accessories: PBM FBM31CA (furnished with PBMI)	1	Option 02
6	Application devices PBM FBM31CA Printer GP-250X		 Produced by Fujitsu Produced by Seikosha

Note

Items 1 to 3 configure a standard PTA, while items 4 to 6 are optional.
Items 1 and 2 are incorporated in the MS560J.

2.2 Specifications

Table 2-2 Specifications

Display	Number of display characters		42 characters x 21 lines = 882 characters
	Displayable characters		Upper and lower case characters, numerals, special symbols, and cursor (total: 96 characters)
	Character font		5 x 7 dot matrix
	Graphic		2 screens (High and Low intensity displays), each 255 x 217 dots
Keyboard	Character key		Upper and lower case letters, numerals, special symbols (total: 50 keys)
	Edit key		[DEL] [INS] [∧] [∨] [<] [>]
	Command key		[RUN] [STE] [EOL] [RES]
	Switch key		[S1] [S2]
Memory	Program area		12k bytes
PTL	Command		Basic commands (8 types) and PBM control commands (3 types)
	Statement		Basic statements (15 types) and GP-IB statement (2 types)
	Function		Arithmetic functions (12 types), boolean functions (4 types), and system functions (8 types)
	System subroutine		Display subroutines (4 types), GP-IB subroutines (2 types), and buzzer subroutine.
	Variable		Numeric, string, and system variables
	Data type	Single-precision integer	1 byte: 0 to 255
		Double-precision integer	2 bytes: –32768 to +32767
		Single-precision real number	4 bytes: Number of effective digits is 7, and exponential range is 10^{-20} to 10^{18}
		Double-precision real number	8 bytes: Number of effective digits is 14, and exponential range is 10^{-14} to 10^{13}
		Character	Maximum: 128 bytes
		Bit	Maximum: 8 bits
	Interface		GP-IB and I/O port
PBM	Circuit system		Serial loop
	Storage capacity		8K bytes (User area is 7.5K bytes)
	Program file		Maximum: 30 programs

2.3 Connector for I/O Port

PIN NO.	ITEM	SPECIFICATIONS	VARIABLE NAME
1	GND		
2	INPUT 1	TTL level, negative logic	EXO
3	OUTPUT 1	" "	
4	OUTPUT 2	" "	
5	OUTPUT PORT A 0	" "	TA
6	" " 1	" "	
7	" " 2	" "	
8	" " 3	" "	
9	" " 4	" "	
10	" " 5	" "	
11	" " 6	" "	
12	" " 7	" "	
13	OUTPUT PORT B 0	" "	IB
14	" " 1	" "	
15	" " 2	" "	
16	" " 3	" "	
17	" " 4	" "	
18	" " 5	" "	
19	" " 6	" "	
20	" " 7	" "	
21	INPUT/OUTPUT PORT C 0	" "	IC
22	" " 1	" "	
23	" " 2	" "	
24	" " 3	" "	
25	INPUT/OUTPUT PORT D 0	" "	ID
26	" " 1	" "	
27	" " 2	" "	
28	" " 3	" "	
29	PORT C STATUS	" 0/1: Output/Input	EIO
30	PORT D STATUS	" 0/1: Output/Input	
31	NRITE · STORE SIGNAL	" negative logic	*
32	NC		
33	NC		
34	+5V	Max. 100mA	
35	X → S switching signal	Open collector	
36	+20V	Max. 100mA	

* This is output at IC = . . . , ID = . . . statement execution.

Note

See Paragraph 5.3.1(5) I/O port and Paragraph 7.6 I/O port control for details on system variables.

SECTION 3 OPERATION

PTA is controlled using the keys on the front panel of MS560J or from a personal computer via a GP-IB interface.

3.1 PTA Activation and Termination

When the power switch is turned on, measurement data is displayed on the CRT screen as shown in Fig. 3-1. However, PTA is not yet activated.

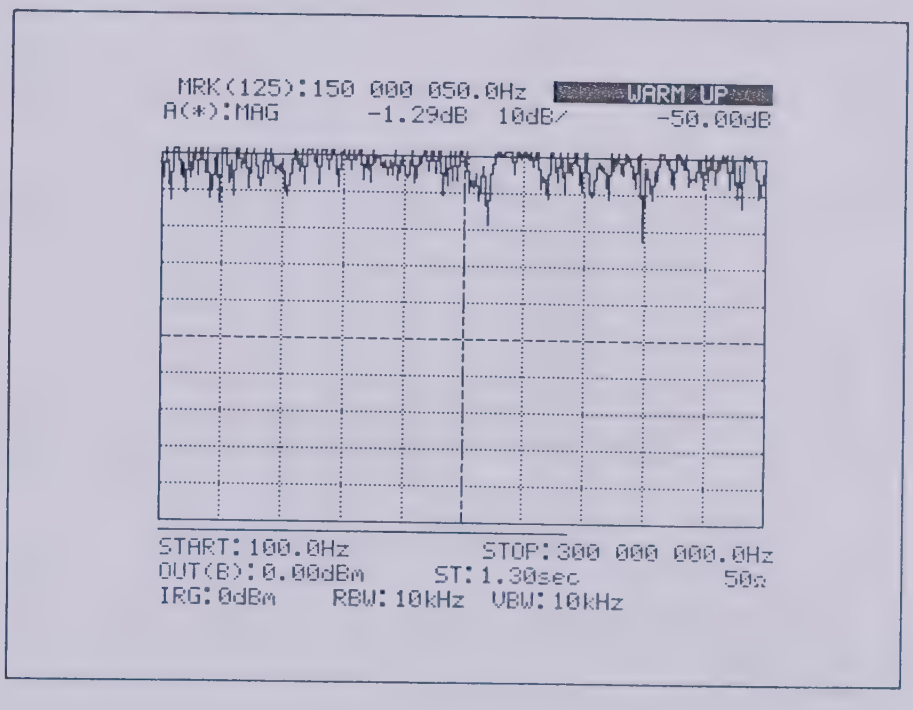


Fig. 3-1 Screen at Power On

(1) PTA Activation

The PTA lamp turns on or off whenever the PTA key is pressed. Turning the PTA lamp off during the program execution, the program suspends execution. If the lamp is turned on later, execution is restarted from the instruction following the one at which execution was suspended. Turning the PTA lamp on or off during the program execution does not effect the display on the CRT.

Terminating the program execution clears the screen and positions the cursor at the upper left (called HOME POSITION) as shown in Fig. 3-2.

Note that data can be input only while the cursor is displayed.

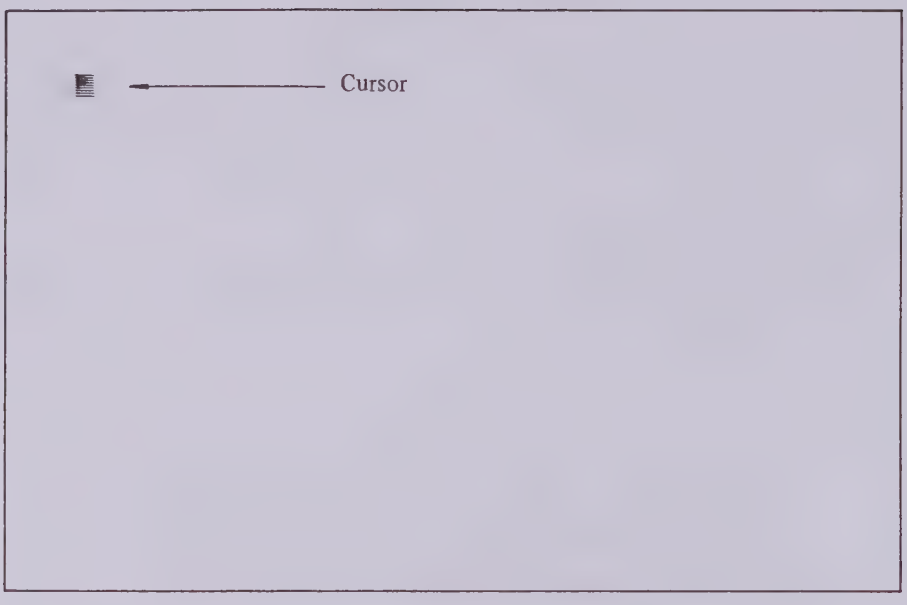


Fig. 3-2 Screen at PTA Activation

3.2 Key Operation

PTA operations are performed using the keys on the front panel of MS560J. PTL program are input, edited, and executed by PTL commands. Fig. 3-3 shows an example program for obtaining the sum of 1 through 10.

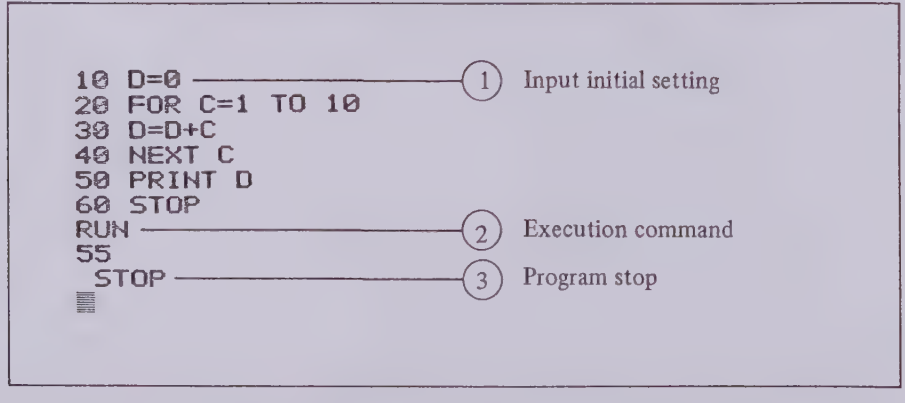


Fig. 3-3 An Example of a Program for Obtaining the Sum of 1 through 10

① ..... Input a program by pressing keys [1] [0] [SP] [D] [=] [0] [EOL] in this order:

② ..... The RUN key can also be used.

③ ..... Indicates program termination.

When command execution ends, the cursor appears at the head of the next line, indicating that data can be keyed-in.

3.2.1 Character Keys

These keys are used to input characters. When one of these keys is pressed, the character is input at the position where the cursor is displayed, and the cursor moves one column to the right. When the cursor reaches the right-most column position, it moves to the first column position of the next line. A different character can be input with the same key by using the SHIFT key. The SHIFT key is either on or off and must be set as required. Characters that can be input are shown in Table 3-1.

Table 3-1 Character Code List

Character Key	SHIFT Key OFF	ON/OFF ON
A ~ Z	A ~ Z	a ~ z
# (	(	#
$)	)	$
*	*	*
+	+	+
" ,	,	"
–	–	–
/	/	/
; :	:	;

Character Key	SHIFT Key OFF	ON/OFF ON
! ?	?	!
<	<	<
=	=	=
>	>	>
.	.	.
SP	␣	␣
0 ~ 9	0 ~ 9	0 ~ 9
Ω	Ω	Ω

3.2.2 Cursor Keys

These keys move the cursor to the right, left, up, and down. There are four keys, as shown.

3.2.3 Character Deletion Key

When the DEL key is pressed, the character in the cursor position is deleted and the right side characters are shifted one column to the left. The cursor position remains unchanged.

3.2.4 Space Insertion Key

When the INS key is pressed, space for a character is inserted immediately before the cursor position. The characters to the right plus the cursor position are shifted one character position to the right. The cursor position remains unchanged (immediately after the inserted space).

3.2.5 Command Execution Key

When the [EOL] key is pressed, the command on the line where the cursor is placed is executed. The cursor moves to the first character position of the next line when execution ends.

3.2.6 Program Execution Keys

When the [RUN] key is pressed, the program is executed starting from the command on the first line.

When the [STE] key is pressed, only the command on the line where the cursor is displayed is executed. When execution ends, the cursor moves to the first character position of the next line.

For details, see Paragraph 4.2 Execution Commands.

3.2.7 Program Switch Setting Keys

These switches are used for referencing the program. The [S1] and [S2] key statuses are referenced by system variables EX1 and EX2. For example, when the [S1] key is on, EX1=1 is set where it is off, EX1=0 is set. The [S1] and [S2] keys are off at powering when the [RES] and [PTA] keys are pressed. For details on system variables EX1 and EX2, see "System variables for control function" in Table 5-14 of paragraph 5.3.1.

3.2.8 Reset Key

Program execution stops when the [RES] key is pressed.

(1) Stops execution of commands and programs, and displays the cursor in the first character position of the next line.

(2) Sets keys S1 and S2 to OFF. (EX1=EX2=0)

(3) Cuts off the I/O port.

3.3 Screen Data Deletion

The following two methods are available for deleting data displayed on the screen while PTA lamp is on.

(1) As shown in Figs. 3-4 to 3-6, by the ERASE command after moving the cursor to the home position (upper left corner) with the cursor key or the HOME command.

The screen shown in Fig. 3-4 is deleted by the following procedure:

(i) Move the cursor to the HOME POSITION with the HOME command or the cursor key.

(ii) Execute the ERASE command as shown in Fig. 3-4 (2).

(iii) The screen is cleared and the cursor appears at the upper left of the screen.

(2) By turning the PTA key OFF and then ON.

However, this should be done only when the program execution is completed (in the RESET or STOP state).

Contents of the program and execution status remain unchanged.

```
10 REM "SIN CURVE"
20 REM
30 REM " "
40 REM
50 CALL CRTS(0,100," 0",2)
60 CALL CRTS(0,200," 1",2)
70 CALL CRTS(0,0,"-1",2)
80 CALL CRTS(180,200,"Sin Curve",0)
90 K=0
100 J2=K*2
105 EX1=0
110 P=SIN(J2)*100+101.5
120 C=K+20
130 FOR K=0 TO 180
140 J1=K*2
150 P1=SIN(J1)*100+101.5
160 C1=K+20
170 CALL CRTG(C,P,C1,P1,0)
180 C=C1
190 P=P1
```

Fig. 3-4 Screen Data Deletion Method 1 (1)

Cursor Key

```
ERASE
20 REM
30 REM " "
40 REM
50 CALL CRTS(0,100," 0",2)
60 CALL CRTS(0,200," 1",2)
70 CALL CRTS(0,0,"-1",2)
80 CALL CRTS(180,200,"Sin Curve",0)
90 K=0
100 J2=K*2
105 EX1=0
110 P=SIN(J2)*100+101.5
120 C=K+20
130 FOR K=0 TO 180
140 J1=K*2
150 P1=SIN(J1)*100+101.5
160 C1=K+20
170 CALL CRTG(C,P,C1,P1,0)
180 C=C1
190 P=P1
```

Fig. 3-5 Screen Data Deletion Method 1 (2)

Pressing the EOL key executes the ERASE command.

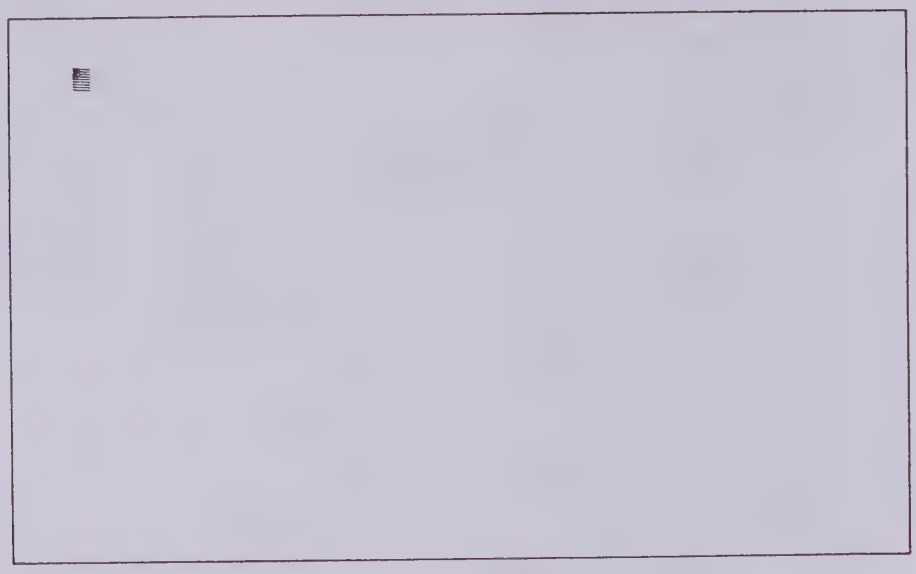


Fig. 3-6 Screen Data Deletion Method 1 (3)

3.4 Entering a PTA Application Program from Personal Computer via GP-IB

PTA application programs can be input to PTA from a personal computer through the GP-IB in the following two ways. Application programs stored in an MS560J can also be read into and field in a personal computer via the GP-IB.

Note that the MS560J must be a acting as a device (not a controller) when the above operations are carried out. Refer to the GP-IB Operation Manual for the procedure that sets the MS560J to device mode.

Program input procedures are explained using a program for an Anritsu Packet IIe Personal Technical Computer.

3.4.1 Method 1

Entering a PTA Program in the same way as using the MS560J Front Panel Keys.

Enter the following program on a Packet IIe computer.

```
 10 DIM A$*42              ; Sets the size of the character string variable to 42 characters.
 20 WRITE @101:"PT1"       ; Sets PTA to ON.
 30 WRITE @101:CHR$(5)     ; Sets the program or command input mode to ON.
 40 LINE INPUT A$          ; Inputs a program or command line.
 50 IF A$="END" THEN 80    ; If the input command is END, terminates execution of this
                             program.
 60 WRITE @101:A$          ; Inputs a program or command line to MS560J
 70 GO TO 40               ; Repeats execution of statements 40 to 70 until END is input to
                             A$.
 80 WRITE @101:CHR$(6)     ; Sets the program or command input mode to OFF.
 90 WRITE @101:"PT0"       ; Sets PTA to OFF.
100 END
```

3.4.2 Method 2

(1) Storing a PTA Program on Floppy Disk of Personal Computer.

Enter the following program on a Packet IIe computer.

The input program is saved on a floppy disk under the file name PTA. If the user wants to save under different file name, code the desired name in place of "PTA" in the OPEN statement of line number 60.

```
 10 DIM A$*42
 20 WRITE @101:"PT1"              ; Sets PTA to ON.
 30 WAIT DELAY 1                  ; Waits for one second after setting PTA to ON.
 40 WRITE @101:CHR$(4)            ; Outputs CHR$ (4) to MS560J twice.
 50 WRITE @101:CHR$(4)            ; Enables the Packet IIe computer to input the application
                                    program.
 60 OPEN #1:NAME "PTA",OUTPUT     ; Opens the PTA file in the floppy disk.
 70 READ @101:A$                  ; Inputs a line of program from MS560J.
 80 PRINT #1:A$                   ; Saves a line of program in the PTA file.
 90 IF A$="END" THEN 110          ; MS560J output "End" at the end of PTA application
                                    program
100 GO TO 70
110 CLOSE #1                      ; Closes the PTA file.
120 WRITE @101:CHR$(3)            ; Sets the MS560J program output mode to OFF.
130 WRITE @101:"PT0"              ; Sets PTA to OFF.
140 END
```

(2) Transferring a PTA Program to MS560J after Loading It from Floppy Disk.

Enter the following program on a Packet IIe computer.

```
 10 DIM A$*42
 20 WRITE @101:"PT1"          ; Sets PTA to ON.
 30 WRITE @101:CHR$(4)        ; Sets the MS560J program input mode to ON.
 40 OPEN #1:NAME "PTA"        ; Opens the PTA file on the floppy disk.
 50 LINE INPUT #1:A$          ; Loads a line of program from the PTA file.
 60 IF A$="END" THEN 90
 70 WRITE @101:A$             ; Outputs a line of program to the MS560J.
 80 GO TO 50
 90 CLOSE #1                  ; Closes file PTA on the floppy disk.
100 WRITE @101:CHR$(3)        ; Sets the MS560J program input mode to OFF.
110 WRITE @101:"PT0"          ; Sets PTA to OFF.
120 END
```

Note

Before execution of this program, the file PTA of the application program created on the MS560J must be saved in the procedure shown in item (1).

SECTION 4 PTL COMMANDS

Programs described in Personal Test Language (PTL) is edited and executed by PTL commands.

The PTL commands and their functions are shown in Fig. 4-1 and Table 4-1.

The program creation flow is shown in Fig. 4-2.

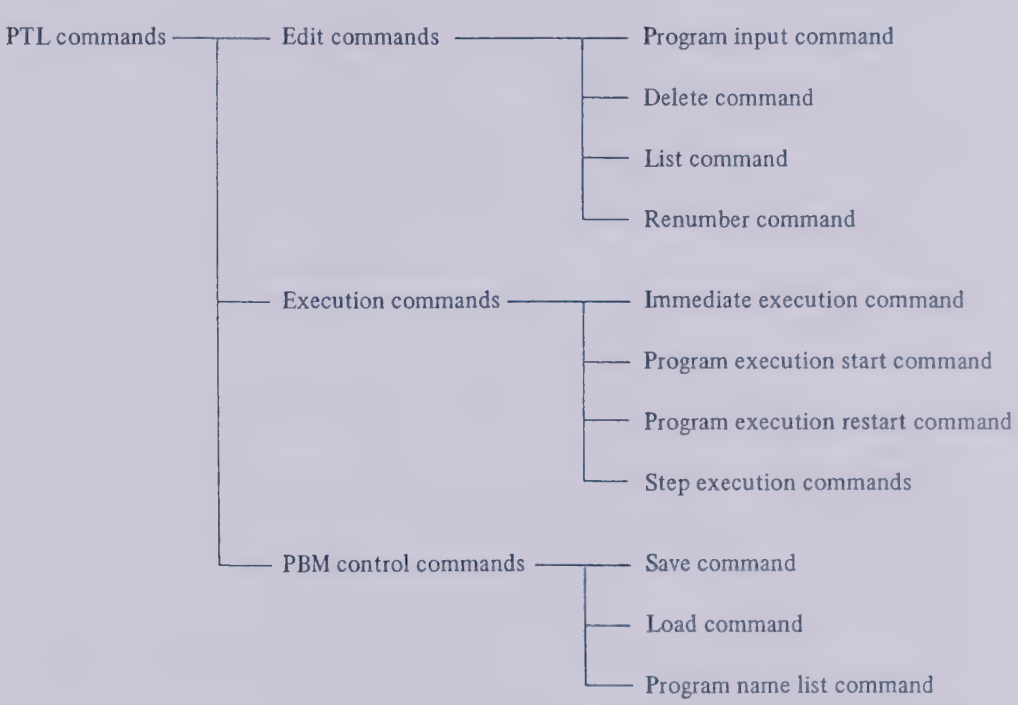


Fig. 4-1 PTL command configuration

Table 4-1 Functions of PTL Commands

Number	Name	Command	Functions
1	Program input	–	When a statement with line number is input, this command stores the statement in the RAM as a program.
2	Delete	**DELETE**	Deletes the program.
3	List	**LIST** **LISTG**	Displays the program list on the screen or outputs it to GP-IB.
4	Renumber	**RENUM**	Renumbers program line numbers.
5	Immediate execute	–	When a statement with no line number is input, this command immediately executes it.
6	Program execution start	**RUN** or [RUN] key	Starts program execution.
7	Program execution restart	**CONT**	Restarts program execution.
8	Step execute	[STE] key	Executes a program line (step).
9	Save	**SAVE**	Saves the program from RAM into the bubble memory.
10	Load	**LOAD**	Loads the program from the bubble memory into RAM.
11	Program name list	**PLIST**	Displays the program name saved in the bubble memory on the screen.

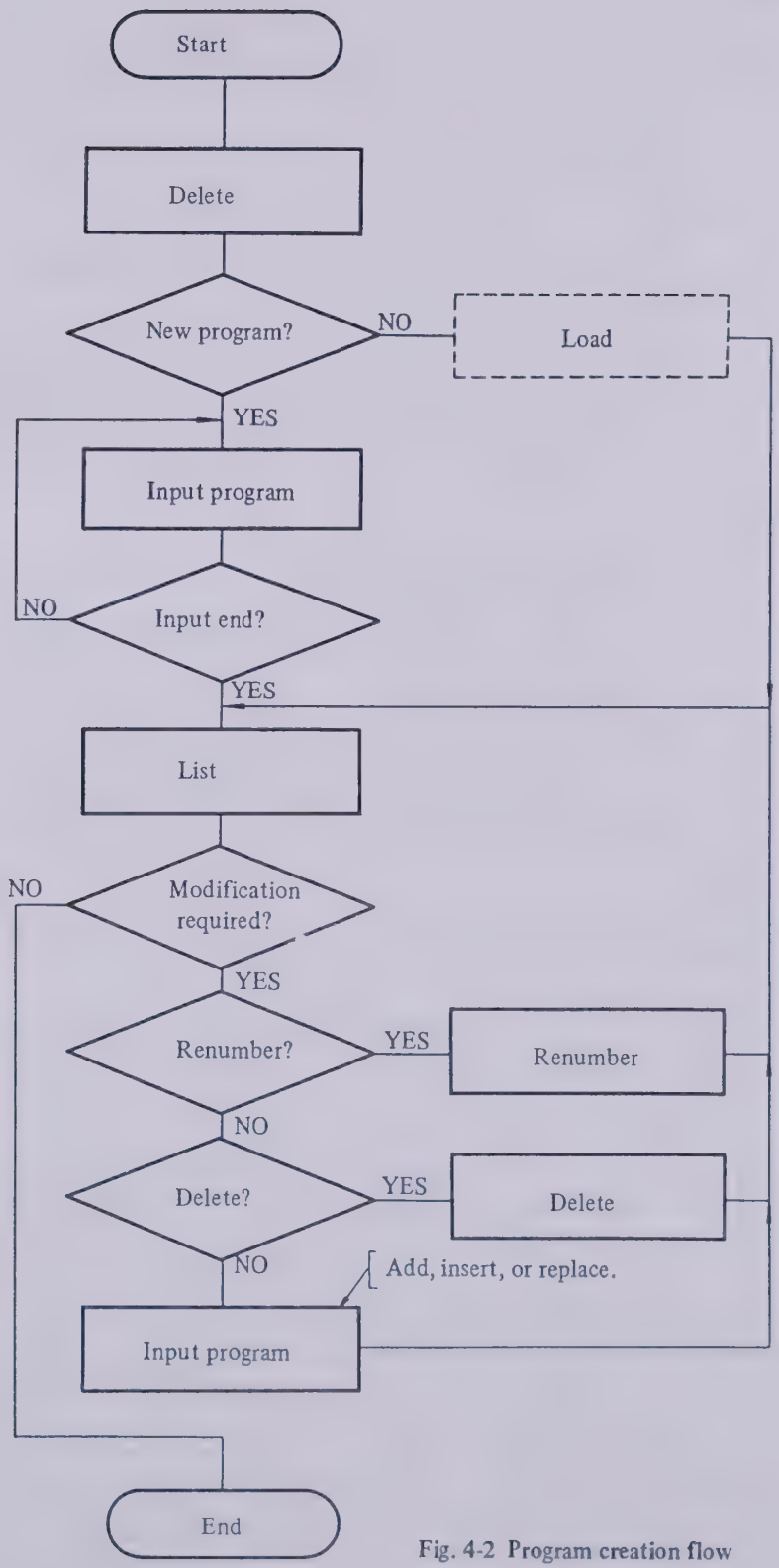


Fig. 4-2 Program creation flow

4.1 Edit Commands

The program input, delete, list, and renumber commands are used to input and modify programs.

4.1.1 Program Input Command

(1) Function

When a statement with a line number is input, this command stores the statement in the program area of RAM as a program.

If the line number is different from the line numbers of previously stored statements, the statement is added to or inserted between the previously stored program or programs. If the line number is the same as that of a stored statement, the previously stored statement is replaced by the statement being input.

(2) Format

Line number **Statement**

1 ~ 9999

Note

If there is an error in the line number or statement, an error message is displayed and the statement is not stored in RAM.

(3) Example

An example of the program input command is shown in Fig. 4-3.

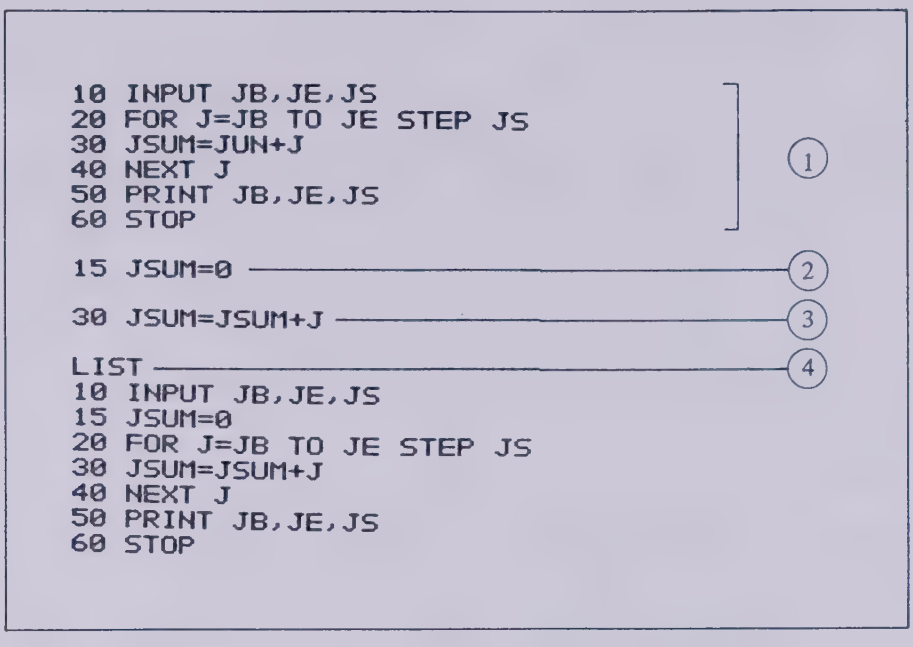


Fig. 4-3 An Example of the Program Input Command

① ..... Inputs the program.
② ..... Inserts the input program since no statement with the same line number exists.
③ ..... Replaces the statement of line ③⓪ of the input program.
④ ..... Lists the results of steps ① through ③ .

4.1.2 Delete Command

(1) Function

This command is used to delete the entire program or parts thereof.

(2) Format

a. Deleting the entire program

DELETE

b. Deleting one line

DELETE Line number

c. Deleting several lines

DELETE [line number $_1$], [line number $_2$]

Statements of line number 1 through line number 2 are deleted. When line number 1 is omitted, statements of the first line through line number 2 are deleted; when line number 2 is omitted, statements of line number 1 through the last line number are deleted.

Note

Even if there is an error in the command and an error message is displayed, the contents of the program remain unchanged.

(3) Example

An example of the delete command is shown in Fig. 4-4.

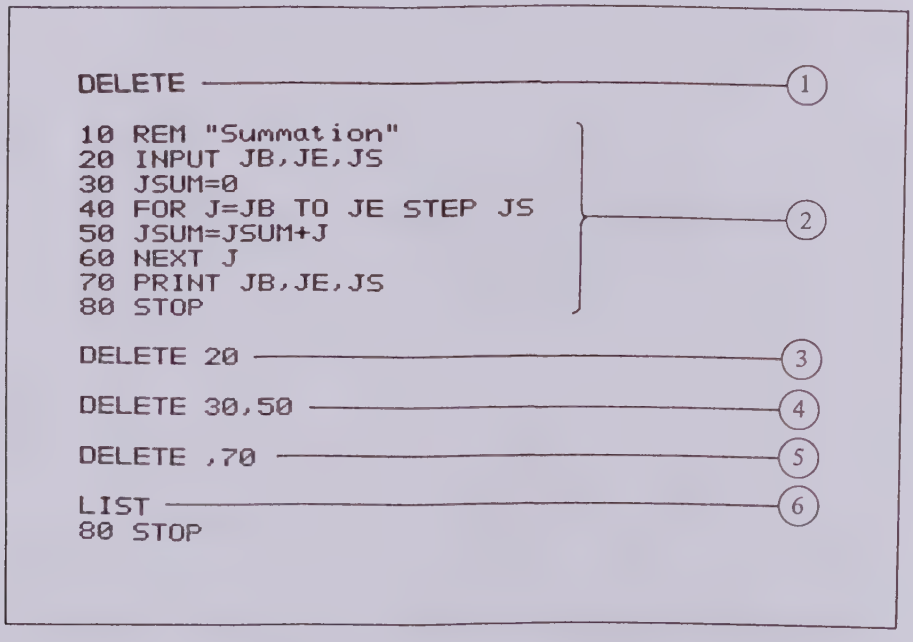


Fig. 4-4 An Example of the Delete Command

① ..... Deletes the entire program.
② ..... Input the program
③ ..... Deletes the statement of line 20.
④ ..... Deletes the statements of lines 30 through 50.
④ ..... Deletes the statements of the first line through line 70.
⑥ ..... Lists the results of steps ② through ④.

4.1.3 List Commands

(1) Function

There are two list commands; LIST which is used to display part of or the entire program on the screen, and LISTG which is used to output part of or the entire program to the device on GP-IB.

(2) Format

a. Listing the entire program

- Display on the screen

  LIST

- Output to the device on GP-IB

  LISTG address (Address: Address of GP-IB device)

  address: 0 ~ 30

b. Listing one line

- Display on the screen

  LIST line number

- Output to the device on GP-IB

  LISTG address, line number

  address: 0 ~ 30

c. Listing several lines

- Display on the screen

  LIST [line number $_1$], [line number $_2$]

- Output to the device on GP-IB

  LISTG address, [line number $_1$], line number $_2$

  Outputs statements of line number 1 through line number 2. When line number 1 is omitted, statements of the first line through line number 2 are output; when line number 2 is omitted, statements of line number 1 through the last line number are output.
  In the case of LISTG, line number 2 can not be omitted.

Note

If there is no statement with line number 2 when listing several lines, statements up to the statement with the closest line number to line number 2 output.

(3) Example

An example of the LIST command is shown in Fig. 4-5.

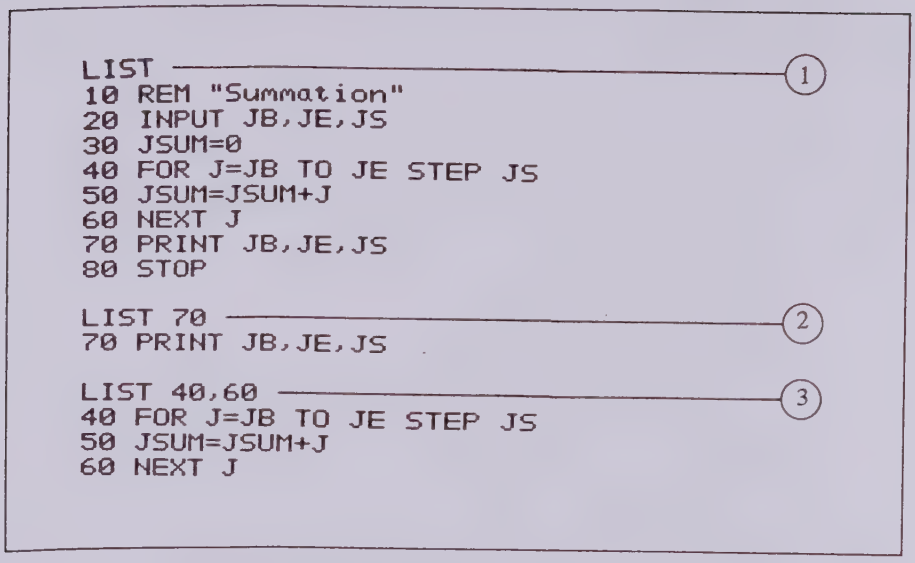


Fig. 4-5 An Example of the LIST Command

① ..... Lists the entire program.
② ..... Lists the statement of line 70.
③ ..... Lists the statements of lines 40 through 60.

4.1.4 Renumber Command

(1) Function

This command renumbers line numbers used in the program. This command is effective when listing is difficult because line numbers are not in order or when line numbers are too close for new statements to be inserted.

(2) Format

a. Renumbering the entire program

RENUM [new first line number, [increment]]

This specification renumbers, in the increment specified, all statements starting from the new first line number.
The default value for the new first line number and increment is 10.

b. Renumbering part of the program

RENUM [new line number], [increment], current line number

This specification renumbers, in the increment specified, all statements subsequent to the statement with the specified line number. The default value for the new line number and increment is 10.

Note

1. *An error does not occur even if renumbered line numbers are smaller than the preceding line numbers.*

2. *If renumbering is done, relevant jump addresses used in GOTO and GOSUB statements must be corrected by the user or programmer since they are not automatically corrected by this renumbering function.*

(3) Examples

Examples of the renumber command are shown in Figs. 4-6 to 4-9.

```
LIST ——————————————————————————— (1)
1 INPUT J
2 GOSUB 4
3 STOP
4 T=SQR(J)
5 PRINT T
6 RETURN

RENUM ——————————————————————————— (2)

LIST ——————————————————————————— (3)
10 INPUT J
20 GOSUB 4
30 STOP
40 T=SQR(J)
50 PRINT T
60 RETURN
```

Fig. 4-6 An Example of the Renumber Command (1)

(1) ..... Lists the program with current line numbers.

(2) ..... Renumbers all program statements starting from the new first line number 10 in increments of 10.

(3) ..... Lists the results of step (2).

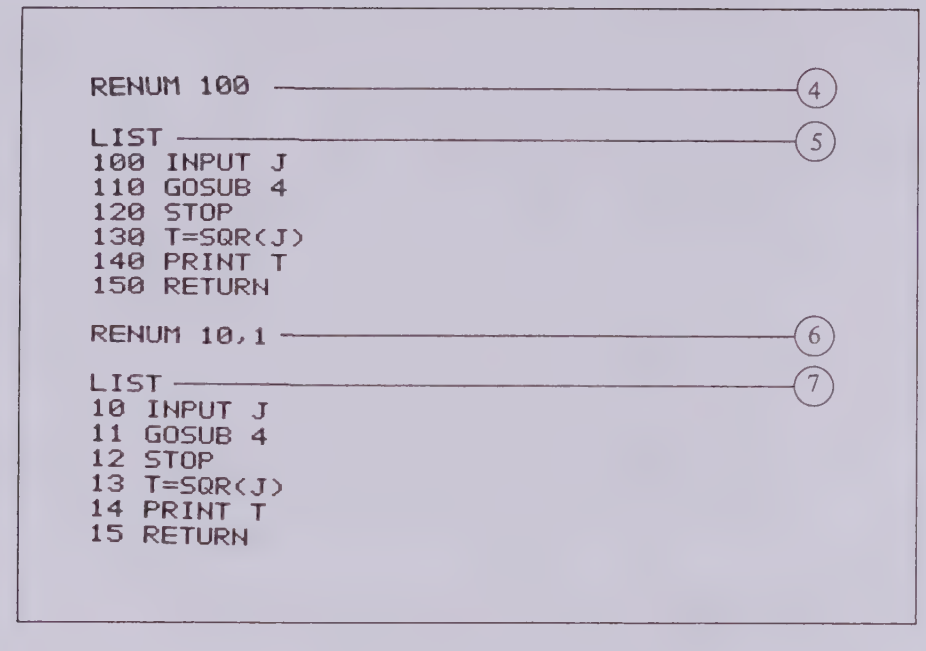


Fig. 4-7 An Example of the Renumber Command (2)

④ ..... Renumbers all program statements starting from the new first line number 100 in increments of 10.

⑤ ..... Lists the results of step ④ .

⑥ ..... Renumbers all program statements starting from the new line number 10 in increments of 1.

⑦ ..... Lists the results of step ⑥ .

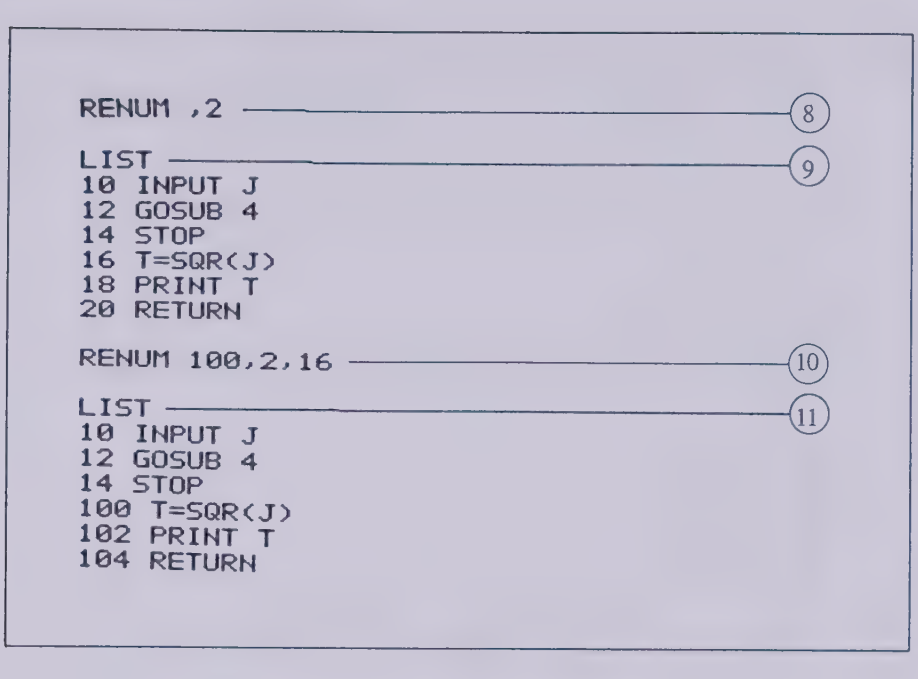


Fig. 4-8 An Example of the Renumber Command (3)

(8) ..... Renumbers all program statements starting from the new line number 10 in increments of 2.

(9) ..... Lists the results of step (8).

(10) ..... Renumbers statements of current line number 16 through the last one starting from the new line number 100 in increments of 2.

(11) ..... Lists the results of step (10).

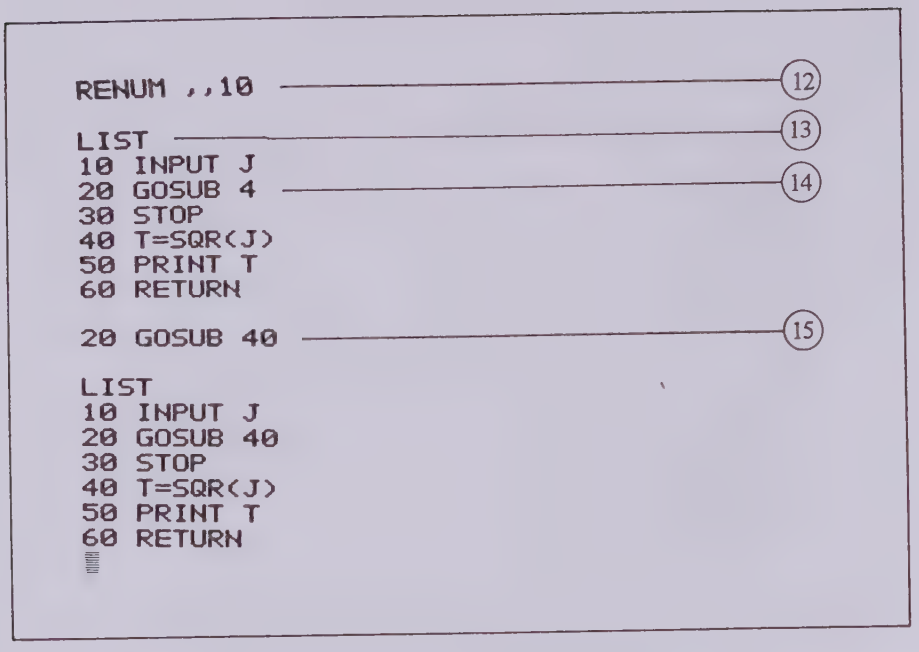


Fig. 4-9 An Example of the Renumber Command (4)

⑫ ..... Renumbers statements of current line number 10 through the last one starting from the new line number 10 in increments of 10.

⑬ ..... Lists the results of step ⑫ .

⑭ ..... The jump address of the GOSUB statement is not automatically modified.

⑮ ..... Modifies the jump address of the GOSUB statement.

4.2 Execution Commands

Program execution is started by inputting an execution command. There are four types of execution commands; immediate execution command, program execution start command, program execution restart command, and step execution command.

4.2.1 Immediate Execution Command

(1) Function

When a statement with no line number is input and the [EOL] key is pressed, the statement is executed immediately.

(2) Format

Statement [EOL]

Note

GOSUB, RETURN, FOR and NEXT statements cannot be used with this command.

4.2.2 Program Execution Start Command

(1) Function

This command starts program execution.
When a STOP statement is executed, an error occurs, or the [RES] key is pressed, program execution ends (enters termination status).
When executing the program specified the suspension line, program execution stops (enters suspension status).

(2) Format

a. Execution with no suspension line specification

RUN [start line number]
or
[RUN] key

If the start line number is omitted or the [RUN] key is pressed, the program is executed from its first statement.

b. Execution with suspension line specification

RUN [start line number], suspension line number

When the statement of the suspension line number is executed, program execution is placed in suspension status. If the start line number is omitted, the program is executed from its first statement.

Note

1. *An error does not occur and execution continues even if there is no statement with the specified suspension line number in the program.*
2. *As regards variables, the results of the program executed previously remain unchanged; they are not initialized by the RUN command.*

4.2.3 Program Execution Restart Command

(1) Function

This command restarts suspended program execution. The conditions for stopping this restarted execution are the same as those for the program execution start command explained in paragraph 4.2.2.

(2) Format

a. Execution with no suspension line specification

CONT

b. Execution with suspension line specification

CONT suspension line number

Program execution is placed in suspended status when the statement of the specified suspension line number is executed.

Note

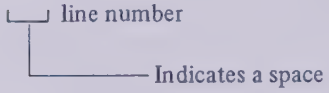
This command can be used only when program execution is in suspend status after executing the program execution start or step execution start command.

4.2.4 Step Execution Command

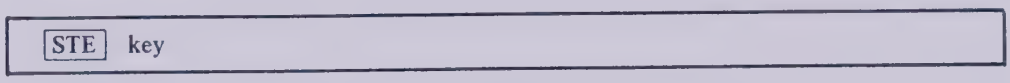
(1) Function

This command executes only one statement line, and displays the executed line number. When program execution is in termination status, the first line statement is executed, and when it is in suspended status, the statement of the line next to the suspension line is executed.

The line number is displayed as follows:



(2) Format



Note

The line number is not displayed when the STOP statement is executed.

4.3 Bubble Control Commands

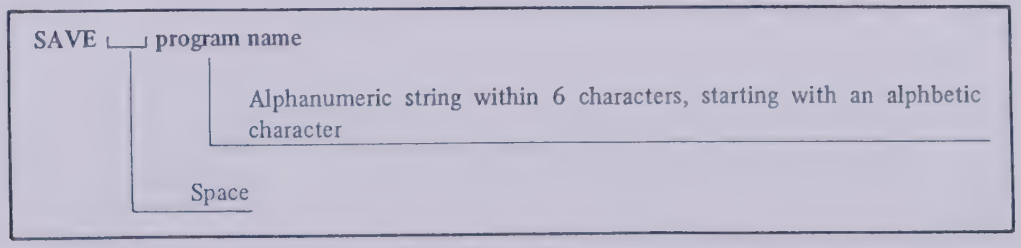
Data is input and output to and from the Plug-in Bubble Memory (PBM) by bubble control command. There are three types of bubble control commands; save command (SAVE), load command (LOAD), and program name list command (PLIST).

4.3.1 Save Command

(1) Function

This command is used to save the entire program in the PBM after giving it a program name. One PBM can store a maximum 30 programs, not exceeding 7.5k bytes in total.

(2) Format



Note

If there is a program with the same program name as that of the program to be saved, the program is replaced by the program to be saved.

(3) Example

A program occupying 7.5K to 12K bytes can be saved in two PBMs by the following procedure:

(i) Check the program size by saving the program in a PBM by the PLIST command. (See paragraph 4.3.3 "Program Name List Command" for details.)

(ii) When the size of the program in the PTA's RAM area reaches about 7K bytes, save it in PBM1.

(iii) Delete the above portion of the program from the PTA's RAM.

(iv) Load the remaining portion of the program into the PTA's RAM and then save it in PBM2.

4.3.2 Load Command

(1) Function

This command loads the specified program stored in a PBM into the program area of the PTA RAM. If programs reside on the RAM, the loaded program is added to, inserted between, or replaces the programs.

(2) Format

LOAD ␣ Program name

Note

Using the DELETE command, programs on the RAM must be deleted before loading new programs.

(3) Example

A program occupying 7.5K to 12K bytes can be loaded in two PBMs by the following procedure:

(i) Load half of the program saved in the procedure explained in paragraph 4.3.1 (3) from PBM1 or PBM2 by the LOAD command.

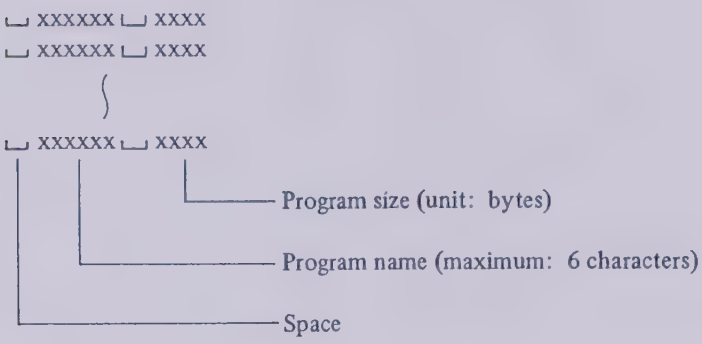
(ii) Add the remaining portion of the program saved in the other PBM to the portion of the program first loaded by the LOAD command.

4.3.3 Program Name List Command

(1) Function

This command displays all program names stored in the PBM.

The display format is as follows:



(2) Format

PLIST

4.3.4 PBM Initialization

When using a new PBM, execute the following ADV function to initialize the PBM:

1. Press [BEGIN] [/] [1] [4] [EOL] keys in this order.
2. Press [G] [0] [EOL] keys in this order.

4.3.5 Program Deletion

There is no specified command that deletes a particular program stored in a PBM. Such a program is deleted by initializing the PBM that contains the program after saving all the other programs in another PBM.

SECTION 5 PTL

Personal Test Language (PTL) is an operation and control language similar to BASIC.

PTL specifications are shown in Table 5-1.

Table 5-1 PTL Specifications

Item No.	Item	Specifications
1	Language level	Network analysis function has been added to the ANSI standard BASIC subset.
2	Program size	(1) Program area: 12k bytes (Approximately 600 lines assuming that there is no variable area) (2) Number of user-defined variables: 60
3	Data type and operation accuracy	(1) Integer type a. Single-precision 0 to 255 b. Double-precision −32, 768 to 32, 767 (2) Single-precision real number type Number of effective digits: 7 Exponent range: 10^{-28} to 10^{18} (3) Double-precision real number type Number of effective digits: 14 Exponent range: 10^{-14} to 10^{13} (4) Character type (1 to 128 bytes) (5) Bit type (1 to 8 bits, 1 byte)
4	Statement	(1) Comment: REM (2) Array declaration: DIM (3) Substitution: LET (4) Control: GOTO, STOP, GOSUB, and RETURN (5) Decision: IF (6) Repetition: FOR and NEXT (7) Input and output: INPUT, PRINT, READ, and WRITE (8) Display control: HOME and ERASE (9) Time wait: WAIT (10) System subroutine execution: CALL

Table 5-1 PTL Specifications (Cont'd)

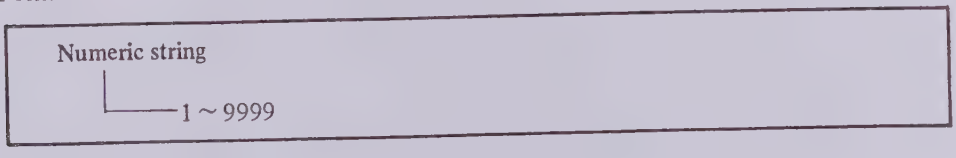
Item No.	Item	Specifications	
5	Function	(1) Arithmetic functions:	SIN, COS, TAN, ASN, ACS, ATN, LN, LOG, EXP, SQR, ABS, and SGN
		(2) Boolean functions:	NOT, AND, OR, and EOR
		(3) System functions:	MAX, MIN, BNDL, BNDH, RPL1, RPL2, POLL, and POLH
6	System subroutine	(1) Display control:	CRTS, CRTG, CRTR, and CRTC
		(2) GP-IB control:	IFC and RSV
		(3) Buzzer:	BZR
7	System variable	(1) Measurement data:	6 types
		(2) Measurement control:	56 types
		(3) I/O ports:	5 types
		(4) External switches:	3 types

5.1 Statement Configuration Elements

5.1.1 Line Number

(1) Function
This line number is placed ahead each statement and serves as an index during program edition or execution.

(2) Format



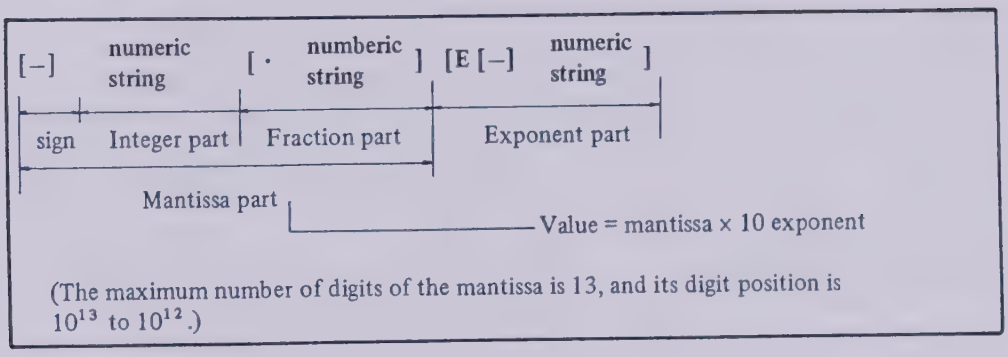
5.1.2 Constants

(1) Function

A constant represents a specific value, string, or bit string.

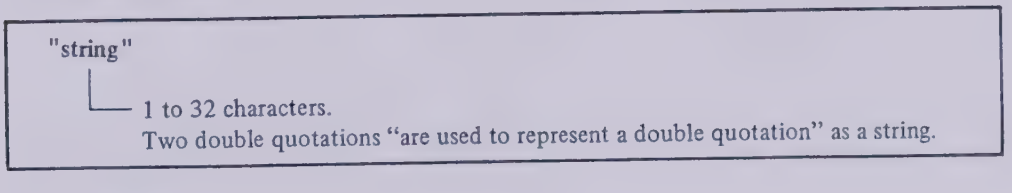
(2) Format

a. Numeric constants

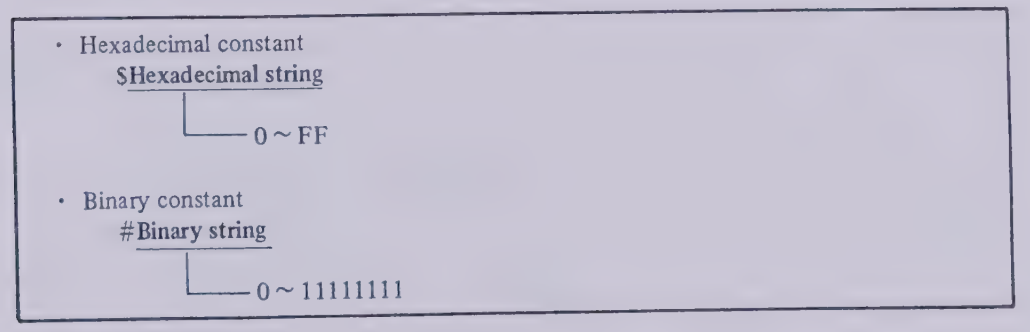


(The maximum number of digits of the mantissa is 13, and its digit position is 10^{13} to 10^{12}.)

b. Character constants



c. Bit constants



(3) Examples

a. Numeric constants
1
–12.3
12E3 – – – – – – Equal to 12000
–0.12E-3 .– – – – Equal to –0.00012

b. Character constant
"Who are you"

c. Bit constants
$SF – – – – – – – Equal to #1111 (binary) or 15 (decimal)
#00011010 – – – Equal to $1A (hexadecimal) or 26 (decimal)

5.1.3 Variable Names

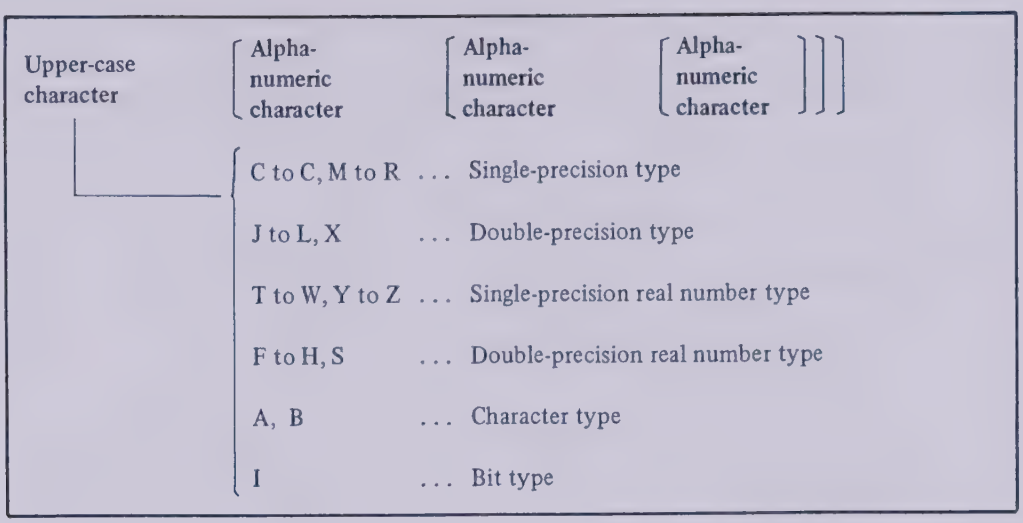
(1) Function

A variable name represents a specific value, string, or bit string. Variable types and characteristics of variables are shown in Table 5-2.

Table 5-2 Variable Types and Characteristics

Number	Type	Characteristics
1	Single-precision integer	This represents an integer from 0 through 255. Since the required RAM capacity is small and operation speed is high, this type of variable is used for operations where small positive integer data is handled. This also can be used as a subscript for an array.
2	Double-precision integer	This represents an integer from –32768 through 32767. This is effective in handling integer data which cannot be expressed in one byte containing no sign bit.
3	Single-precision real number	This represents a real number greater than 10^{-21} and smaller than 10^{19}. The number of effective digits is 7. Although the required RAM capacity is small and operation speed is high, errors are included. Most numeric functions operate using floating-point binary numbers. This type of variable is used for operations using real number data whose errors are permitted or for operation data containing numeric functions.
4	Double-precision real number	This represents a real number greater than 10^{-15} and smaller than 10^{14}. The number of effective digits is 14. Although errors are not included, there are limitations on operation functions.
5	Character	This type of variable represents characters of the ASCII code system. When an array is declared, these characters can be used as strings.
6	Bit	This type of variable represents bit data. When an array is declared, these can be used as bit strings.

(2) Format



Note

1. *A variable is described within four characters starting with an upper-case alphabetic character.*
2. *The variable type is determined by the first upper-case character as shown above.*

(3) Alphabetic strings that cannot be defined as variables

a. Single-precision integer type variables

CALL, CONT, COS, CRTC, CRTG, CRTR, CRTS, DIM, EOR, EXP, MAX, MIN, NEXT, NOT, OR, POLL, POLH, READ, REM, RPL1, RPL2, RSV, RUN

System variables CAM, CIT, CAL, CMS, CME, CBP, CMP, CSM, CBZ, DTR, DLN, DEX, DST, DSA, BSB, DZO, DDK, DMK, DMP, EX0, EX1, EX2, EIO, MF0, MF1, MLW, MTK, MCF, MCP, MXS, MTA, MTV, MIR, MRB, MVB, MDR, MOP, MIM, MOV, MUC, MIG, MMH, MFC, MOM

b. Double-precision integer type variables

LN, LOG

System variables L (*), LV0, LV1, LV2, XA (*), XB (*), XSA (*), XSB (*), XTG, XOA, XOB

c. Single-precision real number type variables

TAN, TO, WAIT

d. Double-precision real number type variables

GOTO, HOME, SAVE, SGN, SIN, SQR, STEP, STOP

System variables F (*), FC0, FC1, FS0, FS1, FFC, FOF, SWT, SCT

e. Character type variables

ABS, ACS, ASN, ATN

f. Bit type variables

System variables IA, IB, IC, ID

Note

L(*), XA(*), XB(*), XSA(*), XSB(*), and F(*) are system variables defined as array elements.

5.1.4 Array

(1) Function

A variable for which array has been declared is called an array and it represents a data string. A variable with a subscript is referred to as an array element and it represents data in the data string. See "Array declaration" in paragraph 5.2.2 for details.
A variable for which array has not been declared is called an independent variable.

(2) Format

a. Array (entire)

Variable name – – – Represents all data of the array (character and bit types)

b. Array element

Variable name (Numeric constant)
└ Subscript: 0 to array size –1

Note

When the subscript is a real number, the right-side digits of the decimal point are turncated.

5.1.5 Functions

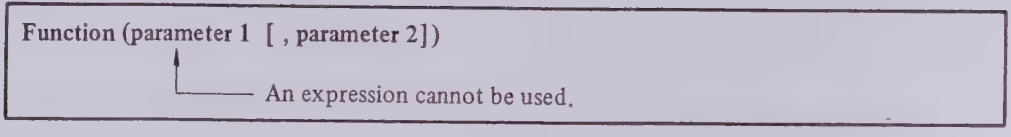
(1) Function

These function commands compute values of functions such as trigonometric and boolean functions. For system functions, see "System functions" in paragraph 5.3.2.
Basic functions are shown in Table 5-3.

Table 5-3 Basic Function List

Number	Function name	Function	Variable type	Parameter
1	Sine	SIN	Single-precision real number type	Numeric constant or numeric variable (unit: degree)
2	Cosine	COS		
3	Tangent	TAN		
4	Arc sine	ASN		Numeric constant or numeric variable ($\lvert$ value $\rvert \leqslant 1$)
5	Arc cosine	ACS		
6	Arc tangent	ATN		Numeric constant or numeric variable
7	Natural logarithm	LN		Numeric constant or numeric variable (value $\geqslant 0$)
8	Common logarithm	LOG		
9	Exponent	EXP		Numeric constant or numeric variable ($\lvert$ value $\rvert \leqslant 32$)
10	Square root	SQR		Numeric constant or numeric variable (value $\geqslant 0$)
11	Absolute value	ABS	Parameter attribute (Constant is double-precision real	Numeric constant or numeric variable
12	Sign	SGN		Numeric constant or numeric variable Note: When the value is greater than or equal to 0, this bit value is 1, and when the value is less than 0, it is −1.
13	Negation	NOT	Bit	Bit constant or bit variable
14	Conjunction	AND		Two bit constants or bit variables
15	Logical sum	OR		
16	Exclusive OR	EOR		

(2) Format



(3) Example

SIN (30)

LOG (TDAT)

AND (IDAT, $F)

5.1.6 Arithmetic Operators

(1) Function

These operators perform addition, subtraction, multiplication, division, and exponential operations.

(2) Format

=	Substitution
+	Addition
–	Subtraction
*	Multiplication
/	Division
!	Exponential operation
( )	Represents the operation priority. Operations in parentheses are performed first.

(3) Operation Priority

a. Operation priority is shown in Table 5-4.

Table 5-4 Operation Priority for Arithmetic Operators

Operation priority	Arithmetic operator
High ↓ Low	!
	* /
	+–
	=

Note

1. Bits and characters cannot be used in operations.
2. X is a positive number in operation X ! Y.
3. If there is a different variable type on the right side of an equals sign (=). an overflow or underflow error may occur.

(4) Example

```
A = "abc"
C = (D + 100)/E
J = ((K+1)*10+M)*10
```

5.1.7 Relation Operators

(1) Function

These operators perform relational operations.

(2) Format

=	– – – – –	Equal
>< or <>	– – – – –	Not equal (≠)
>	– – – – –	Greater than
<= or =<	– – – – –	Equal to or less than
<	– – – – –	Less than
>= or =>	– – – – –	Equal to or greater than

(3) Examples

```
IF C=0 GOTO 100
IF JKL>=168 STOP
```

5.1.8 Formats

(1) Function

Specifies the format of strings in I/O operations. Integers, real numbers with no exponents, real numbers with exponents, strings, binary numbers, and hexadecimal numbers can be specified.

(2) Format

- Integer
  : **I number of digits**
- Real number with no exponent
  : **F number of all digits.**
  number of fractional digits
  (number of all digits ⩾ number of fractional digits +2)
- Real number with exponent
  : **E number of all digits.**
  number of fractional digits
  (number of all digits ⩾ number of fractional digits +7)
- String
  : **C number of digits**
- Binary number
  : **B number of digits**
- Hexadecimal number
  : **H number of digits**

Note

The total number of digits must be less than 128. The total number of digits to the right of the decimal point (excluding the decimal point) must be less than 15. If the number to the right of the decimal point in a real number with no exponent (Format F) is 0 (e.g., F7.0), an error is assumed.
This number must be described as 17.

(3) Examples

```
INPUT CIN: I5
PRINT A: C3, J: F10.4
```

5.2 Basic Statements

5.2.1 Comment (REM statement)

(1) Function

This statement gives comments to the program. Since these comments in the program are not executed by the system, they have no effect on program execution.

Note

When a specific statement is described as a comment statement, it must be enclosed by a pair of double quotation marks (") as a character constant.

(2) Format

REM ["comment"]

(3) Examples

REM

REM Data (Ind) + 10 – – > Data (Ind + 1)

REM "Compute average"

5.2.2 Array Declaration (DIM statement)

(1) Function

This statement declares arrays. Arrays must be one-dimensional and have a size between 2 and 255 (that of bit type variables is up to 7).

(2) Format

```
DIM variable-name (array-size)
  [ , variable-name (array-size) . . . . ]
                        └── 2 ~ 255
```

Note

The same variable cannot be redefined. A variable that has been used as an independent variable cannot be declared as an array.

(3) Examples

```
DIM CARR (100)
DIM I (8), ALP (40)
```

(4) System variables which have been declared as arrays unconditionally.

F (*), L(*), XA (*), XB (*), XSA (*), XSB (*)

5.2.3 Substitution (LET statement)

(1) Function

This statement substitutes variables for constants, variables, and results of operations. See "Arithmetic operators" in paragraph 5.1.6 for the operators.

(2) Format

```
[LET] variable = [ ( ]  { Constant }    [ ) ]
                        { variable }
                        { function }

  [arithmetic operator [ ( ]  { constant }    [ ) ] . . . ]
                 +-           { variable }
                 */           { function }
                 !
```

Note

1. *The variable types that can be substituted are shown in Table 5-5, and the variable types after substitution (bits and characters cannot be processed) are shown in Table 5-6.*
2. *If a substitution statement is placed after an IF statement, LET cannot be omitted.*

(3) Program for converting numeric string to character string.
The following is a sample program for substituting single-precision integer type variable E0 for character variable AB.

```
50 DIM A(7),B(7),AB(3)
60 CAM=0
70 DTR=4
80 DST=0
90 DSA=6
```

```
1640 FOR C=1 TO 3
1650 D=3-C
1660 E=E0-E0/10*10
1670 AB(D)=E+48
1680 E0=E0/10
1690 NEXT C
1700 CALL CRTS(29,208,AB,1)
```

Table 5-5 Variable Types that can be Substituted

Left side of the LET statement \ Right side of the LET statement		Single-precision integer	Double-precision integer	Single-precision real number	Double-precision real number	Character		Bit		
						Array element Independent variable	Array	Independent variable	Array elemtnt	Array
Single-precision integer		○	●	●	●	○		○		○
Double-precision integer		●	○	●	●					
Single-precision integer		●	●	○	●					
Double-precision integer		●	●	●	○					
Character	Independent variable Array element	○				⊗	⊗	○		○
	Array					⊗	⊗			
Bit	Independent variable	○				○		○	○	○
	Array element							○	○	○
	Arry	○				○		○	○	○

- ○ indicates no conversion
- ● indicates numeric conversion
- ⊗ indicates that if the size of the substitution value exceeds the value to be substituted, the excess lower digits are truncated or, if it is shorter, spaces are added.

Table 5-6 Variable Types after Substitution

Left side of the operator \ Right side of the operator	Single-precision integer	Double-precision integer	Single-precision real number	Double-precision real number	Numeric constant
Single-precision integer	←	↑	↑	↑	←
Double-precision integer	←	←	↑	↑	←
Single-precision real number	←	←	←	←	←
Double-precision real number	←	←	↑	←	←
Numeric constant	↑	↑	↑	↑	Double-precision real number

- Arrow ← and ↑ indicate that the variable type indicated by the arrow is the one after substitution.
- Bit and character type operations cannot be performed.

5.2.4 Branch (GOTO statement)

(1) Function

This statement changes the sequence of program execution to the statement of the specified line number.

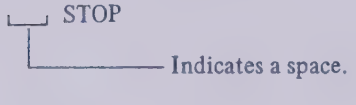
(2) Format

```
GOTO line-number
```

5.2.5 Execution Termination (STOP statement)

(1) Function

This statement terminates program execution after displaying an execution termination message on the screen as follows.



(2) Format

```
STOP
```

Note

If a suspension specification is made in the STOP statement, suspension status does not occur because program execution terminates.

5.2.6 Branch to Subroutines (GOSUB statement)

(1) Function

This statement changes the sequence of program execution to the subroutine with the specified line number. When the RETURN statement is executed at the end of the subroutine, the program sequence is returned to the statement next to the GOSUB statement.

(2) Format

```
GOSUB line-number
```

Note

This is referred to as "nesting" since another subroutine is called during execution of a subroutine. Up to 10 nesting levels are permitted in PTA.

5.2.7 Return From Subroutines (RETURN statement)

(1) Function

This statement returns the sequence of program execution from the subroutine to the statement next to the GOSUB statement.

(2) Format

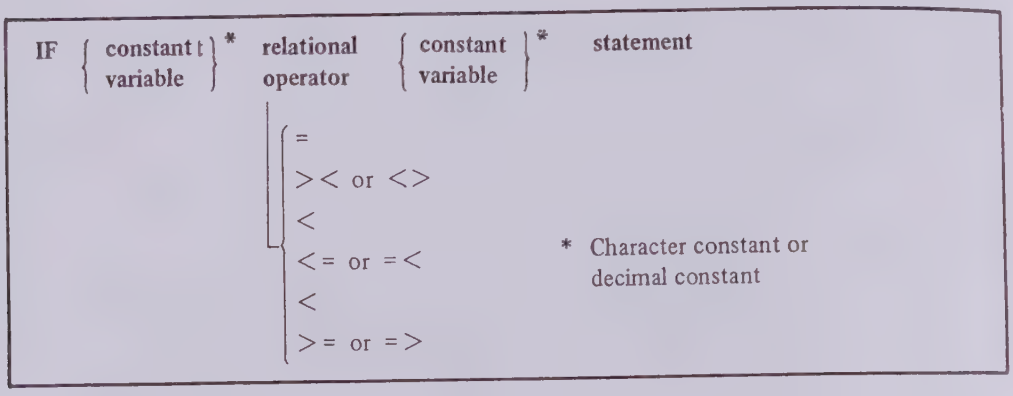
```
RETURN
```

5.2.8 Decision (IF statement)

(1) Function

If the result of the relational operation is true, this statement executes the subordinate statement. For relational operators, see paragraph 5.1.7. Relational operators.

(2) Format



Note

1. *All statements including IF statements can be placed as subordinate statements.*
2. *Relational operations can be performed between different types of numeric variables, but not between numbers, characters, and bits.*
3. *If a substitution statement is placed after an IF statement, LET cannot be omitted.*

(3) Examples

```
IF C=1 GOTO 100
IF ACH=BCH PRINT ACH
IF C<10 IF C>=20 PRINT "ERROR"
IF C<10 LET C=10
```

5.2.9 Repetition Start (FOR statement)

(1) Function

This statement repeats the statements between this statement and the corresponding FOR statement starting with the specified initial value and ending with the specified ending value.
Up to 10 nesting levels are permitted in a FOR statement.

(2) Format

FOR numeric value = { numeric constant / numeric variable } **TO** { numeric constant / numeric variable } [**STEP** { numeric constant / numeric variable }]

- Initial value
- Ending value
- Increment (> 0; default value is 1)

Note

1. *Even if the initial value exceeds the ending value, one cycle operation is performed.*
2. *There are no restrictions on the positional relationship between a FOR statement and its corresponding NEXT statement as long as their execution sequence is correct.*

(3) Example

```
FOR C=1 TO 100
FOR T=TB TO TE STEP 0.1

NEXT T
NEXT C
```

Repeats

5.2.10 Repetition Termination (NEXT statement)

(1) Function

This statement is used with its corresponding FOR statement to terminate the repeated operation.

(2) Format

NEXT numeric variable

└── The same variable specified in the FOR statement

5.2.11 Key-Input (INPUT statement)

(1) Function

This statement is used to input data using the keys on the front panel.
When this statement is executed, the following message is displayed on the screen.
? ▨

Input data after the displayed? (question mark) in the same way as that for command input, then press the EOL key.
For format data, input the specified number of digits, and for unformat data, use commas as delimiters if required.

(2) Format

INPUT variable [format] [, variable [format] . . . . .]

Note

1. *When format is specified for a numeric type variable, only the number of all digits has meaning, and there are no restrictions on its format. If a real number is input for an integer type variable, its fractional digits are truncated. Its format is the same as that for a numeric constant.*
2. *If the size of the input data is smaller than the character type variable, spaces are added, and if it is greater, its excess lower digits are truncated.*
3. *For numeric and bit type variables, spaces before and after the input value are ignored.*
4. *Data cannot be input in binary or hexadecimal without specifying the corresponding format.*

(3) Examples

```
INPUT C                    →  ? 123
INPUT C, A, I              →  ? 123, Q, 101101
INPUT C:I2, J:I4           →  ? 12 – 123
                                C   D
INPUT T:F5.1, U:E10.3      →  ?␣1.23 – 5␣␣␣␣␣␣␣␣␣
                                 T        U
```

5.2.12 Display (PRINT statement)

(1) Function

This statement edits data and displays it following the previous PRINT statement if no line-feed has been specified in the previous statement, or displays it on the next line if line-feed has been specified.
Unformat data is displayed after spaces have been added after its effective digits. The formats and output formats are shown in Table 5-7.

Table 5-7 Formats and Output Formats

Number	Format	Output Format
1	I	Zero-suppressed integer (e.g., ␣ ␣ 123)
2	F	Zero-suppressed integer [. zero-suppressed fraction] (e.g., ␣ ␣123.45␣)
3	E	{ ␣ / − } 0. zero-suppressed fraction E [−] exponent (e.g., ␣0.123 ␣ ␣ E-2 ␣)
4	C	String − If the size of data is smaller than the specified format size, spaces are added, and if it is greater, the excess lower digits are truncated.
5	B / H	Zero-suppressed binary number/hexadecimal number string (e.g., ␣ ␣ 1011)

(2) Format

PRINT
{ variable [format] / string constant } [, { variable [format] / string constant } ..] [;]
- Constant is displayed as is.
- No linefeed

Note

1. If the number of characters in a line exceeds 42, the excess characters are truncated.
*2. Values which cannot be expressed are displayed as *** . . . *.*

- The variables for measurement data are array variables. An asterisk corresponds to a measurement point.
- The minimum size double-precision integer is the minimum resolution of the measurement item.

Example: When the measurement item is magnitude; XA 128) = –9988 → –99.88 (dB)

These are output in the following formats with the decimal point.

```
10 GXA (N) = XA (N)          ; GXA (N) = –1234
20 GXA (N) = GXA (N) * 0.01  ; GXA (N) = –12.34
```

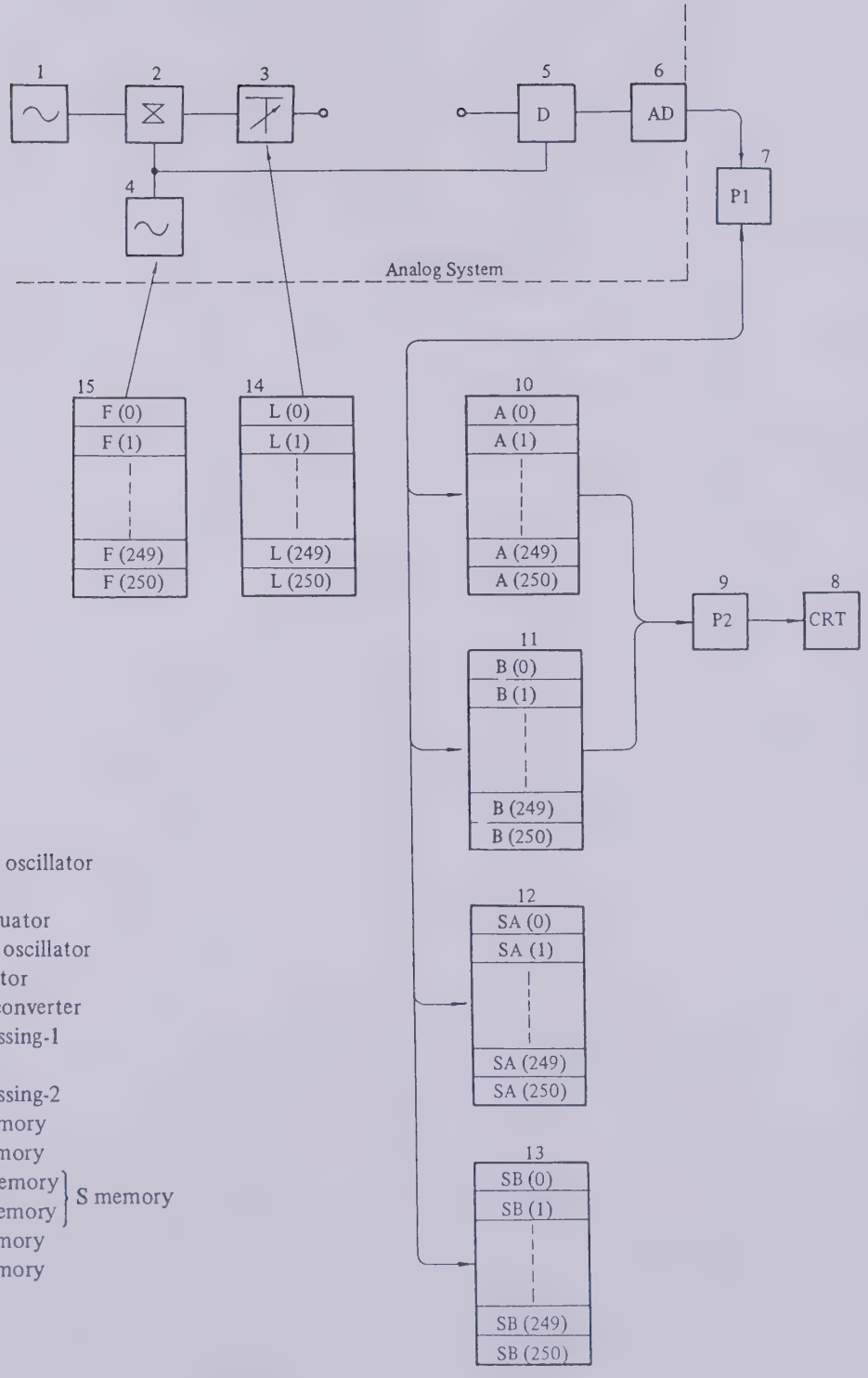
Note

GXA (N) is a double-precision real number.

(ii) Memory system

The MS560J performs measurements on the basis of configuration memory. Descriptions are loaded in this memory system as described below. Figure 5-1 shows how this system is connected to an analog system. The flow of measurements based on this figure is shown in Fig. 5-2. The X values (measured values at each point) in the figure are stored in memories A, B, SA, and SB through the flow shown in Table 5-9. P2 processing as shown in the table is the adjustment of SCALE and OFFSET.

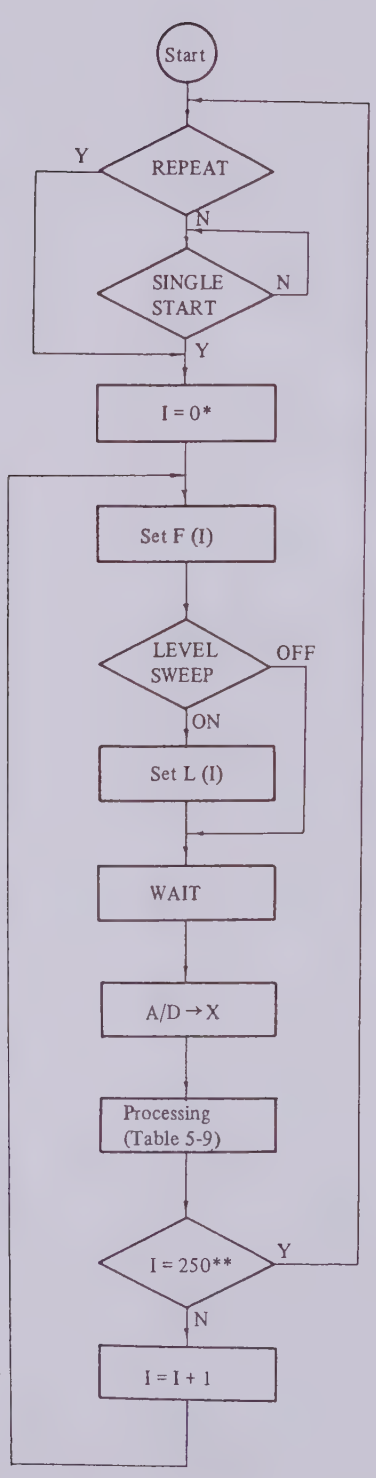
Figure 5-3 shows the operating functions for these memories. This figure shows how to control an element of each memory by peripheral units. For example, if the GP-IB and PTA option are used, it means that all memories can be operated freely.



Notes:

1. Fixed oscillator
2. Mixer
3. Attenuator
4. Local oscillator
5. Detector
6. A/D converter
7. Processing-1
8. CRT
9. Processing-2
10. A memory
11. B memory
12. SA memory } S memory
13. SB memory }
14. L memory
15. F memory

Fig. 5-1 Memory Configuration



Note

1. For marker sweep operation, * and ** become the value at the marker point.
2. For Δmarker sweep operation, * and ** are the start and stop points, respectively.

Fig. 5-2 Measurement Flowchart

Table 5-9 Data Flow

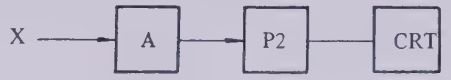
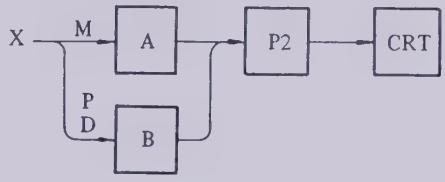
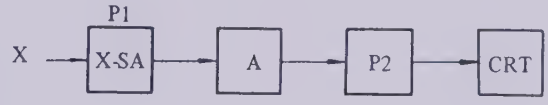
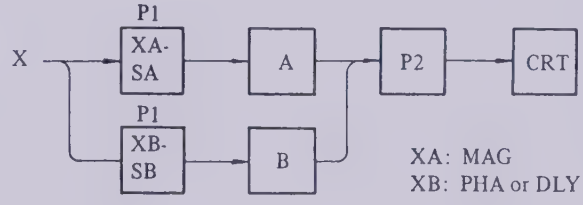
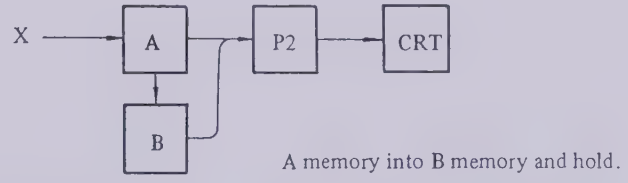
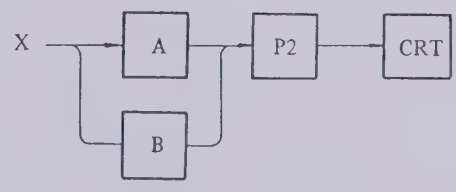
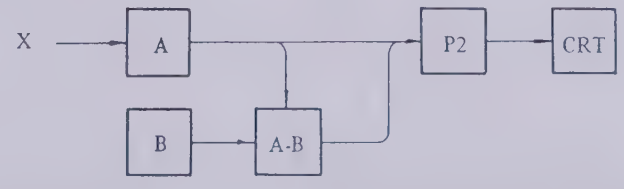
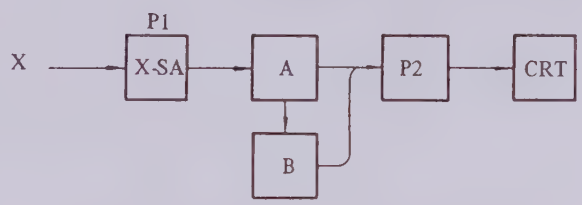
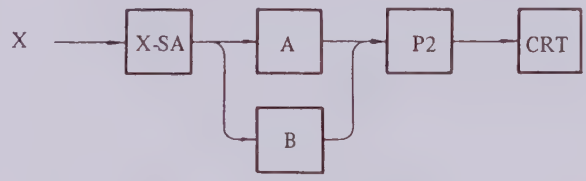
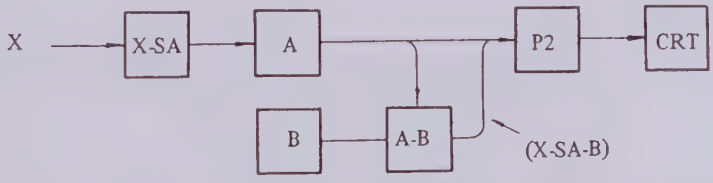
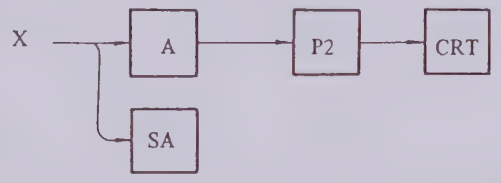
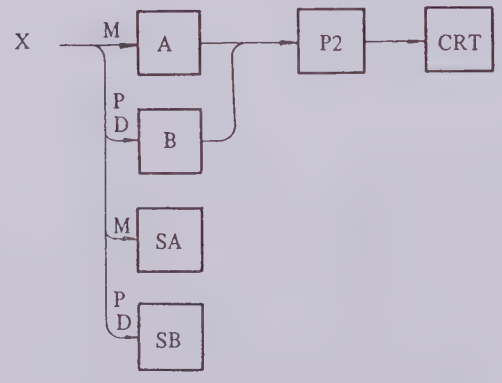
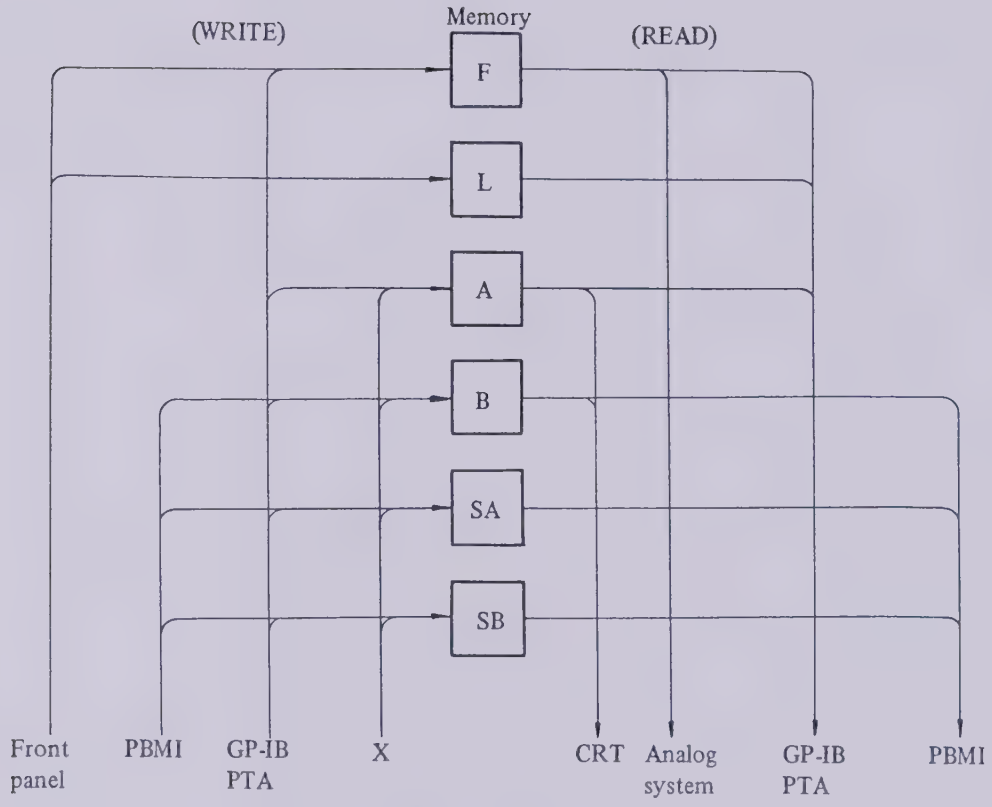
Functions			Data flow
MAG, PHS, DLY, LEVEL, SPECT X-S; OFF SUB TRACE: OFF			
M/P, M/D X-S; OFF SUB TRACE: OFF			
MAG, PHS, DLY, LEVEL, SPECT X-S; ON SUB TRACE: OFF			
M/P, M/D X-S; ON SUB TRACE: OFF			
MAG PHS DLY LEVEL SPECT SUB TRACE : ON	X-S: OFF	A→B	
		B = A	
		B = A – B	

Table 5-9 Data Flow (Cont'd)

Functions			Data flow
MAG PHS DLY LEVEL SPECT SUB TRACE: ON	X-S: ON	A → B	
		B = A	
		B = A – B	
MAG, PHS, DLY, LEVEL, SPECT One sweep after pressing the X → S key.			
M/P, M/D One sweep after pressing the X → S key.			



Variable name

	GP-IB	PTA
F	FQ, FQR, MMR	F
L	LV, LVR, MMR	L
A	XA, XAR	XA
B	XB, XBR	XB
SA	SA, SAR	XSA
SB	SB, SBR	XSB

Fig. 5-3 Memory Access

(2) Display Function

Table 5-10 System Variables for Display Function

ITEM NO.	ITEM	VARIABLE NAME	DATA TYPE	CONTENT
2.1	TRACE	DTR	Single Precision Integer	0: MAG, 1: PHA, 2: DLY, 3: LEVEL(R), 4: LEVEL(T), 5: MAG, 6: M/P. 7: M/D, 8: SPECT(R), 9: SPECT(T). (See Note.)
2.2	LIN	DLN	Single Precision Integer	0: OFF, 1: ON
2.3	EXP	DEX	Single Precision Integer	0: OFF, 1: ON
2.4	SUB TRACE	DST	Single Precision Integer	0: OFF, 1: ON 2: A→B, 3: B=A, 4: B=A-B
2.5	TRIGGER LEVEL	XTG	Double Precision Integer	0 to 3800
2.6	OFFSET A	XOA	Double Precision Integer	–20000 to +20000
2.7	OFFSET B	XOB	Double Precision Integer	–20000 to +20000
2.8	SCALE A	DSA	Single Precision Integer	See Table 5-11
2.7	SCALE B	DSB	Single Precision Integer	See Table 5-11
2.10	ZERO	DZO	Single Precision Integer	0: OFF, 1: ON
2.11	Δ MARKER	DDK	Single Precision Integer	0: OFF, 1: ON
2.12	MAIN MARKER	DMK	Single Precision Integer	0: OFF, 1: ON
2.13	MARKER POINT	DMP	Single Precision Integer	0 to 250

Note

A variable that cannot be loaded.

Table 5-11 Scale

DATA	MAG/LEVEL (R) / (T)	PHA	DLY (DR: at 4 ms)	
0	0.1 (dB/)	1 (deg/)	1 (See Note)	10 (μs/)
1	0.2	2	2	20
2	0.5	5	5	50
3	1	10	10	100
4	2	20	20	200
5	5	50	50	500
6	10	100	100	1 (ms/)
7	20	200	200	2

Note

DLY SCALE is obtained by multiplying the 1/100 of DELAY RANGE (100 ns to 40 ms) by the figure shown in the table.

(3) Measure Function

Table 5-12 System Variables for Measure Functions

ITEM NO.	ITEM		VARIABLE NAME	DATA TYPE	CONTENT	
3.1	FREQ (LOG)	START	NF0	Single Precision Integer	0 to 5	0: 100Hz, 1: 1kHz, 2: 10kHz, 3: 100kHz, 4: 1MHz, 5: 10MHz, 6: 100MHz, 7: 300MHz,
3.2		STOP	MF1	Single Precision Integer	1 to 7	
3.3	FREQ (LIN)	CENTER	FC0	Double Precision Real	100.0 ~ 300000000.0 (Hz)	
3.4		SPAN	FC1	Double Precision Real		
3.5		START	FS0	Double Precision Real		
3.6		STOP	FS1	Double Precision Real		
3.7	LEVEL SWEEP		MLW	Single Precision Integer	0: OFF, 1: ON	
3.8	SIGNAL TRACK		MTK	Single Precision Integer	0: OFF, 1: ON	
3.9	COUPLED TO FREQ		MCF	Single Precision Integer	0: OFF, 1: ON	
3.10	COUPLED TO SPAN		MCP	Single Precision Integer	0: OFF, 1: ON	
3.11	CAL (X-S)		MXS	Single Precision Integer	0: OFF, 1: ON	
3.12	TRACK ADJ		MTA	Single Precision Integer	0: OFF, 1: ON	
3.13	TRACK ADJ VALUE		MTV	Single Precision Integer	0 to 255	
3.14	OUT-PUT LEVEL	START	LV0	Double Precision Integer	−11000 to +1000 (−110.00 to +10.00 dBm)	
3.15		STOP	LV1	Double Precision Integer		
3.16		STEP	LV2	Double Precision Integer		
3.17	SWEEP TIME		SWT	Double Precision Real	100 to 900000000 (ms)	
3.18	INPUT RANGE		MIR	Single Precision Integer	See Table 5-14.	
3.19	RES BW		MRB	Single Precision Integer	1 to 9	See Table 5-13.
3.20	VIDEO BW		MVB	Single Precision Integer	0 to 9	
3.21	DELAY RANGE		MDR	Single Precision Integer	See Table 5-13.	
3.22	OUTPUT A/B		MOP	Single Precision Integer	0: A, 1: B	

Table 5-12 System Variables for Measure Functions (Cont'd)

ITEM NO.	ITEM	VARIABLE NAME	DATA TYPE	CONTENT
3.23	IMPEDANCE	MIN	Single Precision Integer	0: 50Ω, 3: OPT
3.24	OVER LOAD	MOV	Single Precision Integer	1: OVER LOAD (R) (See Note 1) 2: OVER LOAD (T)
3.25	UNCAL	MUC	Single Precision Integer	1: UNCAL (See Note 1)

Note

1. *A variable that cannot be stored.*
2. *Execute WAIT 0.2 when updating the frequency or level table after substituting values into MF0, MF1, FC0, FC1, FS0, FS1, LV0, LV1, and LV2.*

Table 5-13 DELAY/INPUT RANGE, RES/VIDEO BW

DATA	DELAY RANGE	INPUT RANGE	RES/VIDEO BW
0	100 (ns)	–40 (dBm)	1 (Hz)
1	200	–30	3
2	400	–20	10
3	1 (μs)	–10	30
4	2	0	100
5	4	+10	300
6	10	+20	1 (kHz)
7	20		3
8	40		10
9	100		30
10	200		
11	400		
12	1 (ms)		
13	2		
14	4		
15	10		
16	20		
17	40		

(4) Control Function

Table 5-14 System Variables for Control Functions

ITEM NO.	ITEM		VARIABLE NAME	DATA TYPE	CONTENT
4.1	AUTO/MARKER		CAM	Single Precision Integer	0: AUTO, 1: MARKER
4.2	CAL	INT	CIT	Single Precision Integer	0: OFF, 1: ON
4.3		X→S	CAL	Single Precision Integer	0: OFF, 1: ON
4.4	SINGLE START		CMS	Single Precision Integer	0: OFF (Measurement terminated) 1: ON (Under measurement)
4.5	RESET		CME	Single Precision Integer	1: RESET (Note 1)
4.6	S1		EX1	Single Precision Integer	0: OFF, 1: ON
4.7	S2		EX2	Single Precision Integer	0: OFF, 1: ON
4.8	BREAK POINT		CBP	Single Precision Integer	1 to 251 OFF: 252 to 255
4.9	MEASURE POINT		CMP	Single Precision Integer	0 to 250 (Note 2)
4.10	INTEGRATING		MIG	Single Precision Integer	0: OFF, 1: ON
4.11	MAX HOLD		MMH	Single Precision Integer	0: OFF, 1: ON
4.12	FREQ COUNT		MFC	Single Precision Integer	0: OFF, 1: ON
4.13	COUNT FREQ		FFC	Double Precision Real	100 to 300000000 (Hz) (Note 2)
4.14	SWEEP MARKER		CSM	Single Precision Integer	0: OFF, 1: ON
4.15	BUZZER		CBZ	Single Precision Integer	0: OFF, 1: ON
4.16	AUTO CAL. TIME		SCT	Double Precision Real	0 to 99 (minutes)
4.17	REPEAT START		MOM	Single Precision Integer	0: SINGLE 1: REPEAT . . . . . . load data 1: REPEAT START . . . . . . store data

Note

1. *Variable that cannot be loaded.*
2. *Variable that cannot be stored.*

(5) I/O Port

Table 5-15 System Variables for I/O Port

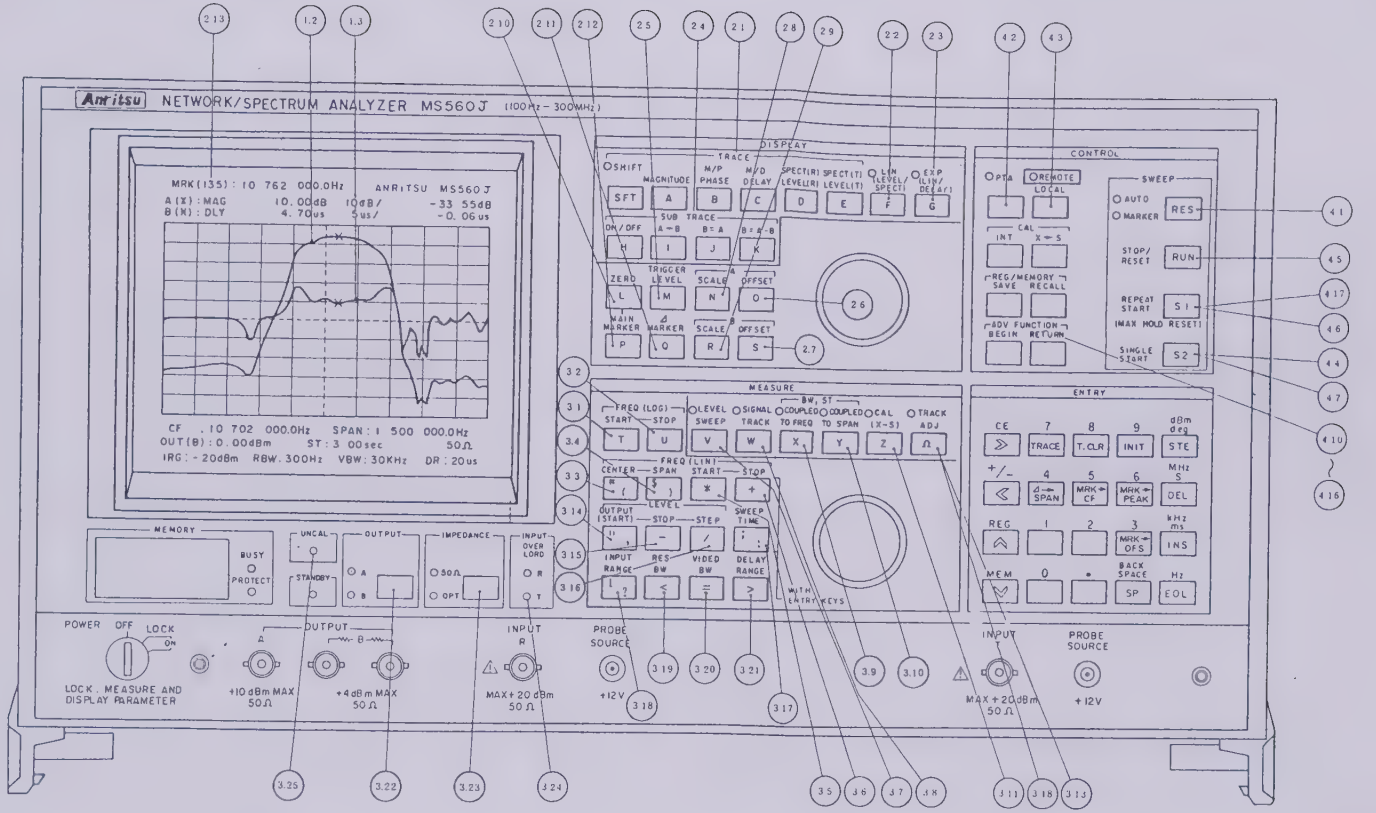
ITEM NO.	ITEM	VARIABLE NAME	DATA TYPE	CONTENT
5.1	EXTERNAL SW	EX0	Integer	See Table 5-16.
5.2	PORT A	IA	Bit	Bits 0 to 7
5.3	PORT B	IB	Bit	Bits 0 to 7
5.4	PORT C	IC	Bit	Bits 0 to 3
5.5	PORT D	ID	Bit	Bits 0 to 3
5.6	PORT STATUS	EIO	Integer	See Table 5-16.

Table 5-16 External Switch and Port Status

DATA	EX0	EIO
0	OUTPUT 1/2 = OFF/OFF INPUT 1 = OFF	PORT C/D = Input/Input
1	OUTPUT 1/2 = ON/OFF INPUT 1 = ON	PORT C/D = Output/Input
2	OUTPUT 1/2 = OFF/ON	PORT C/D = Input/Output
3	OUTPUT 1/2 = ON/ON	PORT C/D = Output/Output

Note

For system variables for I/O port, see paragraph 2.3 "Connector for I/O Port" and paragraph 7.6 "I/O Port Control".



Note: The values in circles ○ represent the item numbers of system variables given in Tables 5-8, 5-10, 5-12, and 5-14.

Fig. 5-4 Correspondence between system variables and MS560J function keys

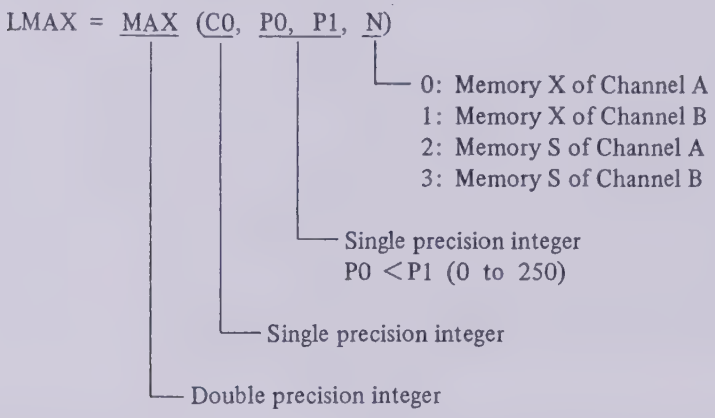
5.3.2 System Functions

(1) MAX (Maximum value point, starting point, termination point, memory area)

MAX (C0, P0, P1, N)

Seek the maximum value in the range P0 to P1 in Area N. The maximum value point is stored at C0. If there are more than one point for the maximum value, the first point will be stored at C0.

○ Data type and range of values



○ Program example

```
10 REM " MAX(C0,P0,P1,N) "
20 GMAX=MAX(C0,0,250,0)
30 GMAX=GMAX*0.01
40 WRITE 0,"Maximum Point = ",C0
50 WRITE 0,"Minimum Loss = ",GMAX,"dB"
60 STOP
Maximum Point = 112
Minimum Loss = -20.45 dB
```

(2) MIN (Minimum value point starting point, terminating point, memory area)

MIN (C0, P0, P1, N)

Seek the minimum value in the range P0 to P1 in Area N. The minimum value point is stored at C0. If there are more than one point for the minimum value, the first point will be stored at C0.

○ Data type and range

(a) Same as in MAX.

○ Program example

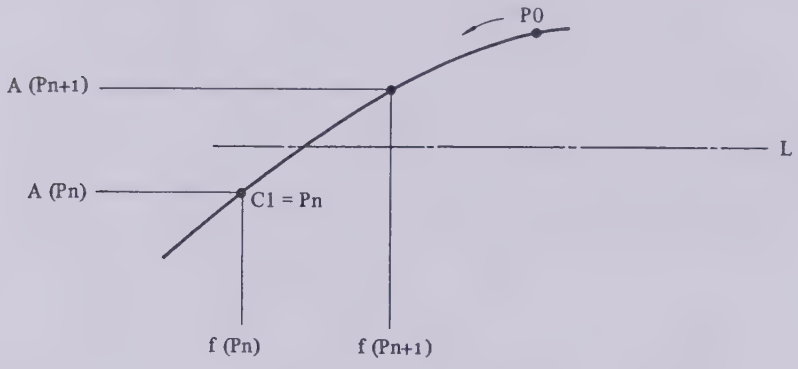
```
10 REM " MIN(C0,P0,P1,N) "
20 GMAX=MAX(C0,0,250,0)
30 GMIN=MIN(C1,0,250,0)
40 GHEN=GMAX-GMIN
50 WRITE 0,"Minimum Point = ",C1
60 GMIN=GMIN*0.01
70 GHEN=GHEN*0.01
80 WRITE 0,"Maximum Loss = ",GMIN,"dB"
90 WRITE 0,"MAX-MIN      = ",GHEN,"dB"
100 STOP

Minimum Point = 230
Maximum Loss = -104.87 dB
MAX-MIN      = 84.42 dB
```

(3) BNDL (Designated measured measured-value point, search start point, designated measured value, memory area)

BNDL (C1, P0, L, N)

Searches the measured value smaller than L from the point P0 in area N as shown below. That designated measured value point is stored at C1, and the frequency for the designated measured value is obtained from the following approximation formula:

$$BNDH = f(Pn) + \frac{f(Pn+1) - f(Pn)}{A(Pn) - A(Pn+1)} \times [A(Pn) - L]$$



○ Data type and range

FBDL = BNDL (C1, P0, L, N)

- N: 0: Memory X of Channel A; 1: Memory X of Channel B; 2: Memory S of Channel A; 3: Memory S of Channel B
- L: Double precision integer
- P0: Single precision integer — 0 to 250
- C1: Single precision integer
- Double precision integer

○ Progam example

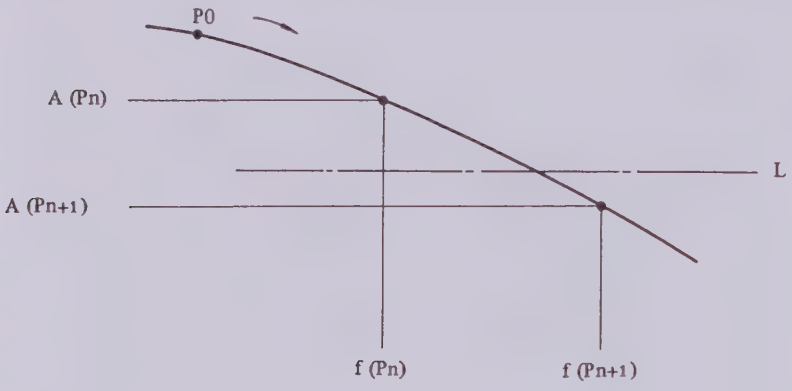
See (d) Program example of BNDH

(4) BNDH (Designated measured value point, search start point, designated measured value, memory area)

BNDH (C2, P0, L, N)

Searches the measured value smaller than L from the point P0 in area N as shown below. That designated measured value point is stored at C2, and the frequency for the designated measured value is obtained from the following approximation formula:

$$BNDH = f(Pn) + \frac{f(Pn+1) - f(Pn)}{A(Pn) - A(Pn\text{-}1)} \times [A(Pn) - L]$$



○ Data type and range

(c) Same as in BNDL.

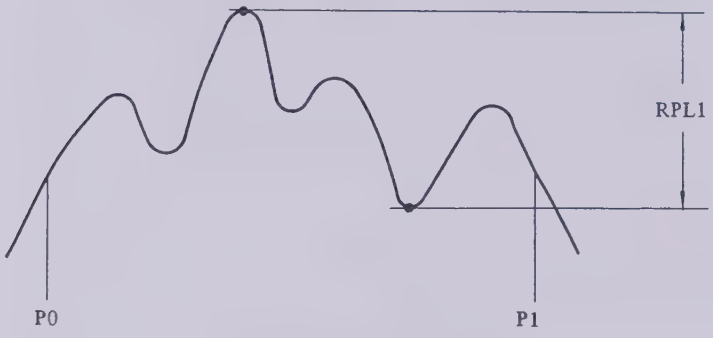
○ Program example

```
10 LMAX=MAX(C0,0,250,0)
20 REM " BNDL(C1,P0,L,N) "
30 REM " BNDH(C2,P0,L,N) "
40 LSTD=LMAX-300
50 FBDL=BNDL(C1,C0,LSTD,0)
60 FBDH=BNDH(C2,C0,LSTD,0)
70 FBND=FBDH-FBDL
80 WRITE 0,"3dB Band Width = ",FBND,"Hz"
90 FROC=FBDL+FBND/2
100 WRITE 0,"Center Freq.  = ",FROC,"Hz"
110 STOP

3dB Band Width = 13664.4 Hz
Center Freq.  = 21399860.0 Hz
```

(5) RPL1 (Starting point, terminating point, memory area)

RPL1 (P0, P1, N)

Seeks the ripple in the range P0 to P1 in area N, as shown below. The ripple means the difference between the maximum value of the top crest and the minimum value of the bottom.



○ Data type and range

LRL1 = RPL1 (P0, P1, N)

- N: 0: Memory X of Channel A
  1: Memory X of Channel B
  2: Memory S of Channel A
  3: Memory S of Channel B
- P0, P1: Single precision integer
- RPL1: Double precision integer

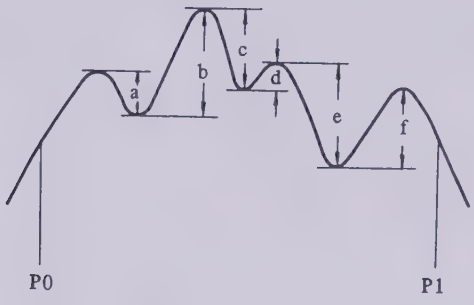
○ Program example

```
10 LMAX=MAX(C0,0,250,0)
20 LSTD=LMAX-300
30 FBDL=BNDL(C1,C0,LSTD,0)
40 FBDH=BNDH(C2,C0,LSTD,0)
50 FBND=FBDH-FBDL
60 WRITE 0,"3dB Band Width = ",FBND,"Hz"
70 FRQC=FBDL+FBND/2
80 WRITE 0,"Center Freq.  = ",FRQC,"Hz"
90 REM " RPL1(C1,C2,0) "
100 GRL1=RPL1(C1,C2,0)
110 GRL1=GRL1*0.01
120 WRITE 0,"Ripple 1 = ",GRL1,"dB"
130 STOP

3dB Band Width = 13664.4 Hz
Center Freq.  = 21399860.0 Hz
Ripple 1 = 1.41 dB
```

(6) RPL2 (Inflection point number, starting point, terminating point, memory area)

RPL2 (CX, P0, P1, N)

Seeks the average value of the difference between the adjacent crest top and bottom in the range P0 to P1 in area N as shown below. The number of adjacent crest top and bottom is stored at CX.



$$RPL2 = \frac{a+b+c+d+e+f}{6}$$

CX = 6

○ Data type and range

LRL2 = RPL2 (CX, P0, P1, N)

- N: 0: Memory X of Channel A; 1: Memory X of Channel B; 2: Memory S of Channel A; 3: Memory S of Channel B
- P1: Single precision integer P0 < P1 (0 to 250)
- P0: Single precision integer
- CX: Double precision integer

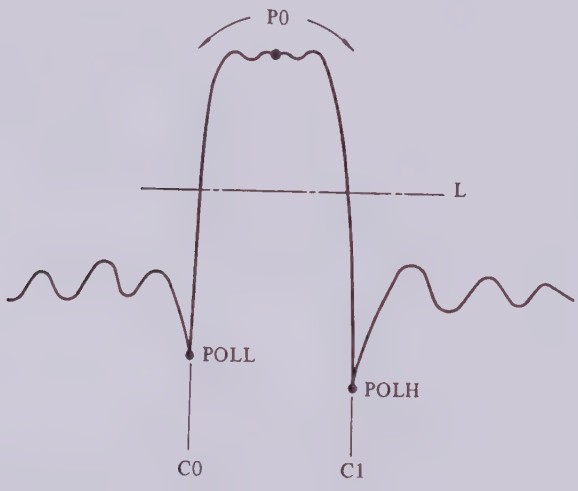
○ Program example

```
10 REM " RPL2(CX,P0,P1,N) "
20 GRL2=RPL2(CX,80,170,0)
30 GRL2=GRL2*0.01
40 WRITE 0," CX       = ",CX
50 WRITE 0,"Riplle 2 = ",GRL2,"dB"
60 STOP

 CX       = 6
Riplle 2 = 0.6 dB
```

(7) POLL (Low range pole point, search starting point, designated attenuation, memory area)
POLH (High range pole point, search starting point, designated attenuation, memory area)

POLL (C0, P0, L, N)
POLH (C1, P0, L, N)

Seeks the pole in the measured area smaller than L by searching from the point P0 in area N as illustrated below. The pole point is stored at C0 and C1 respectively. Lf POLL and POLH cannot be searched, 0 and 250 will be respectively stored at C0 and CL, and the measured values at point 0 and point 250 will be POLL and POLH.



○ Data type and range

LPOL = POLL (C0, P0, L, N)
LPOH = POLH (C1, P0, L, N)

- N: 0: Memory X of Channel A; 1: Memory X of Channel B; 2: Memory S of Channel A; 3: Memory S of Channel B
- L: Double precision integer
- P0: Single precision integer 0 to 250
- C1: Single precision integer
- C0: Double precision integer

○ Program Example

```
10 REM " POLL(C0,P0,L,N) "
20 REM " POLH(C1,P0,L,N) "
30 LSTD=-5000
40 GPLL=POLL(C0,130,LSTD,0)
50 GPLH=POLH(C1,130,LSTD,0)
60 GMX1=MAX(C2,0,C0,0)
70 GMX2=MAX(C3,C1,250,0)
80 GMX1=GMX1*0.01
90 GMX2=GMX2*0.01
100 WRITE 0,"Splious 1 = ",GMX1,"dB"
110 WRITE 0,"Splious 2 = ",GMX2,"dB"
120 STOP

Splious 1 = -80.69 dB
Splious 2 = -82.1 dB
```

(8) Executing Time In System Functions

The executing time of a system function is to be represented by the execution time of the following statement. In other words, it is represented by the sum of the arithmetical operation time of the system function and the executing time of the LET statement.

```
LET LMAX = MAX (C0, 0, 250, 0)
```

Note

As shown in the statement above, this is confined to the case when the variable and system function data formats are the same.

Table 5-17 System Function and Processing Time

System Function	Processing Time
LMAX = MAX (C0, 0, 250, 0)	8 ms
LMIN = MIN (C1, 0, 250, 0)	8 ms
FBDK = BNDL (C2, C0, LCUT, 0)	21 ms
FBDH = BNDH (C3, C0, LCUT, 0)	21 ms
LRL1 = RPL1 (C2, C3, 0)	8 ms
LPL2 = RPL2 (C4, C2, C3, 0)	8 ms
LPOP = POLL (C5, C0, –5000, 0)	6 ms
LPOH = POLH (C6, C0, –5000, 0)	6 ms

5.3.3 System Subroutines

(1) Display Control-1 Subroutine

(a) **CALL CRTC (N)** N: A single precision integer type variable or constant

Erases the SCREEN picture.

N =	0	Erases the entire picture
	1	Erases display line 1
	2	Erases display line 2
	3	Erases display line 3
	4	Erases display line 4
	5	Erases display line 5
	6	Erases display line 6
	7	Erases the whole except the scale
	8	Erases the scale

Note

For the detail, see Fig. 5-5.

(b) **CALL CRTR (N)** N; A single precision integer type variable or constant

Returns the SCREEN picture to normal mode.

N =	0	Returns the entire picture
	1	Returns display line 1
	2	Returns display line 2
	3	Returns display line 3
	4	Returns display line 4
	5	Returns display line 5
	6	Returns dispaly line 6
	7	Returns the measured graph
	8	Returns the scale

(c) **CALL CRTS (X, Y, string, N)**
X, Y, N: Single precision integer type variables or constants

Displays only the string characters from axis X and axis Y of the SCREEN picture.

N =	0	Non-reversed display at high brightness
	1	Reversed display at high brightness
	2	Non-reversed display at low brightness
	3	Reversed display at low brightness

A B C
(X, Y)

Note

Display will be made with one dot deviation from X and Y axis. For the detail of the coordinates, see Table 5-1.

(d) **CALL CRTG (X0, Y0, X1, Y1, N)**
X0, Y0, X1, Y1, N: Single precision integer type variables or constants

Draws a straight line from the coordinates (X0, Y0) to the coordinates (X1, Y1) in the SCREEN picture.

N =	0	Picture at high brightness
	1	Picture at low brightness

Note

For the detail of the coordinates, see Fig. 5-1.

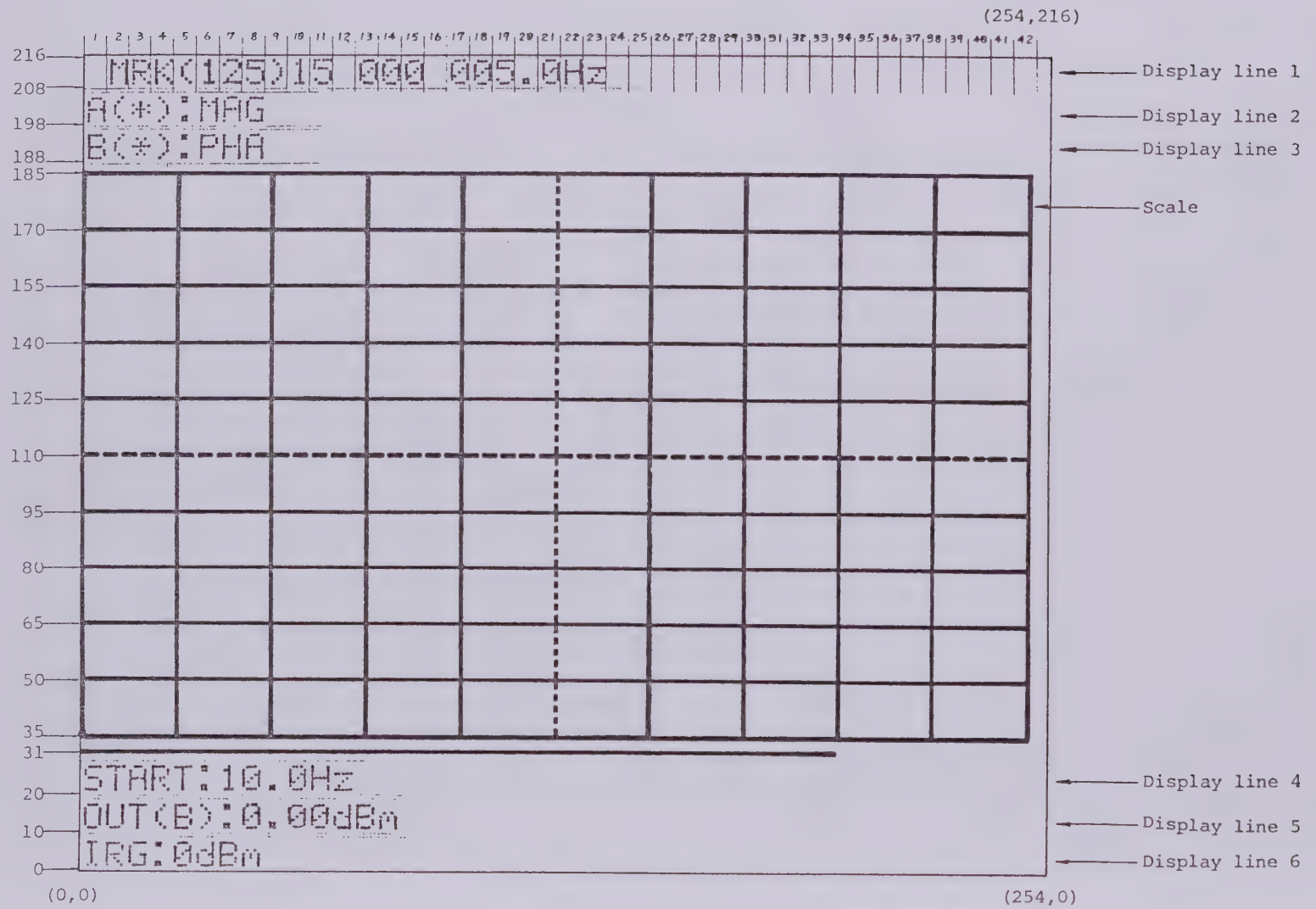


Fig. 5.5 SCREEN Coorinates

(2) GP-IB Control Subroutine

(a) **CALL IFC**

Outputs the "Interface Clear" signal to the GP-IB when the MS560J is the controller. If the MS560J is the device, an error message will be displayed.

(b) **CALL RSV**

Outputs the "SRQ" signal to the GP-IB when the MS560J is the device. If the MS560J is the controller, an error message will be displayed.

(c) **CALL ADR (C)** C: 0 to 32

Modifies the GP-IB address of the MS560J.
MS560J becomes a controller when C is 32.

(3) Buzzer Control Subroutine

(a) **CALL BZR**

Buzzs the buzzer.

5.4 GP-IB Control Statements

GP-IB control statements transfer and receive data controlling the devices connected to the GP-IB when MS560J is used as a controller. These statements also allocate memory space and write data to transfer/receive data to/from a personal computer when MS560J is used as a device.

5.4.1 GP-IB Control Statements When MS560J is a Controller

(1) WRITE address,

{ variable [format] / character constant } [, { variable [format] / character constant } ...] [;]

Data is output to the device specified by the address. If the semicolon is omitted, carriage return (CR) and line-feed (LF) are not output.

○ Program example

```
10 REM "GP-IB STATEMENT"
20 WRITE 0,"abcdefghijklm"
30 WRITE 0,"nopqrstuvwxyz"
40 WRITE 0,"ABCDEFGHIJKLM";
50 WRITE 0,"NOPQRSTUVWXYZ"
60 STOP

abcdefghijklm
nopqrstuvwxyz
ABCDEFGHIJKLMNOPQRSTUVWXYZ
```

(2) READ address, variable [format] [, variable [format] .....]
Data is input from the device specified by the address.

5.4.2 GP-IB Control Statements When MS560J is a Device

(1) WRITE memory number,

{ variable [format] / character constant } [, { variable [format] / character constant } ...]

Data is output to the GP-IB data transfer memory block specified by the memory number. See Fig. 5-6 for the GP-IB data transfer memory map.

(2) READ memory number, variable [format] [, variable [format] ...]

Data is input from the GP-IB data transfer memory block specified by the memory number.

Memory number	Memory capacity
0	16 bytes
1	16 bytes
2	16 bytes
30	16 bytes
31	16 bytes

Total: 512 bytes

Note

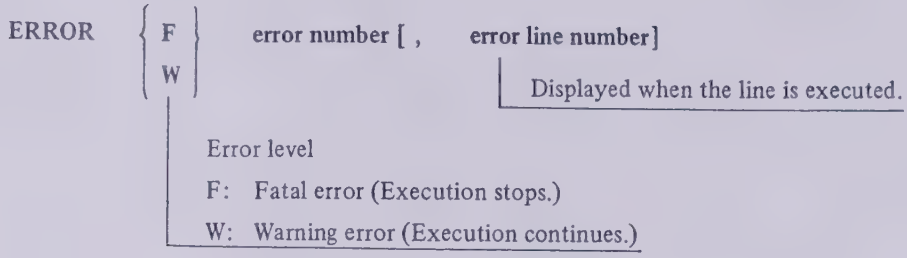
1. *Memory blocks can overlap. For example, if data overflows in memory 1, memory 2 can be used for the overflowed data. However, the memory number cannot be specified in the GP-IB control statement while memory 2 is being used.*
2. *GP-IB memory access commands*
   MYn, ℓ - - - Writes the data of ℓ into memory n.
   MYRn, m - Reads m memories of data starting from memory n.
   n = 0 to 31
   m = 1 to 32

Fig. 5-2 GP-IB Data Transfer Memory Map

The PTA can transmit and receive data to and from an external personal computer using this GP-IB data transmission memory. An example is given in paragraph 7.7 "How to Control the PTA System with a Personal Computer".

SECTION 6 ERROR MESSAGES

An error message is displayed when an error is detected in the command or program. Error messages are output in the following format.



Error numbers, causes of errors, and postprocessing are shown in Table 6-1.

Table 6-1 ERROR LIST

ERROR NO.	ERROR TYPE	CAUSE OF ERROR	REMEDY
0	Syntax error in a command or program.	The [EOL] key was pressed but no command or statement was input.	Disregards the command or program line.
1		The number of the characters representing a variable is exceeding 4. Example: NUMER = 0	(Errors 6 to 8 may occur during execution.)
2		The format of a numerical constant is erroneous. Example: 0 . . . L 4.5EE2	
3		The value of a numerical constant is too large or too small.. Example: −1 (when 1 byte fixed decimal point is binary) 1E-13 (in BCD)	
4		The format of an alphabetical constant is erroneous. Example: "ABC"	
5		The format of writing is erroneous. Example: 3 E8	
6		The statement cannot be interpreted. Example: GOTO ABC	
7		The statement is insufficiently described. Example: GOTO	
8		The statement is excessively described. Example: GOTO 10, 20	
9		The number of variables exceeded 60.	
10		There is a character which cannot be interpreted. Example: IF A < B ?	

Table 6-1 ERROR LIST (Cont'd)

ERROR NO.	ERROR TYPE	CAUSE OF ERROR	REMEDY
11	Syntax error in a command or program.	The format of a binary or hexadecimal constant is erroneous. Example: $G #2	Disregards the command or program line.
12		The value of a binary or hexadecimal constant is too large. Example: $FFF #111111 111	
13		The number of digits of the format is too large. Example: :F49.17	
14		The operand of the command cannot be interpreted. Example: LIST A, B	
15		The operand of the command is insufficient. Example: LISTG	
16		The operand of the command is excessive. Example: DELETE 5, 20, 5	
17		The line number is exceeding 32767. Example: 32768 STOP	
101	Error during command execution	The value of the operand is erroneous. Example: DELETE 30, 20	Stops the execution.
102		The program exceeds 12K bytes.	
103		There is no line number designated by the operand.	
104		The PBM is not mounted.	
105		The PBM is being protected.	
106		The hardware of the PBM is out of order.	
107		There is no room in the PBM (7.5k bytes).	Stops the execution. (Does not create file)

Table 6-1 ERROR LIST (Cont'd)

ERROR NO.	ERROR TYPE	CAUSE OF ERROR	REMEDY
108	Error during command execution	A CRC error arose in the PBM.	Stops the execution (The program remains till the error occurs).
109		The designated program is not on the PBM.	Stops the execution.
110		Nothing is stored in the PBM.	
111		The line number exceeds 32767. Example: RENUM 10000, 10000, 10	
201	Error during execution of the program.	The program cannot be resumed.	
202		The designated line number is lacking. Example: LIST 32768	
203		The value of the array is larger than 256. Example: DIM C (257)	
204		Uses as an independent variable before the array statement. Example: F = 0 DIM F (5)	
205		Double array statement. Example: DIM A (10) DIM A (15)	
206		Inadequate variable memory.	
207		Arithmetic operation of character data or bit data. Example: D = A + 1	
208		Substitution cannot be made. Example: J = A	
209		An overflow or underflow occurred. Example: C = 100 + 200	
210		The divisor is 0. Example: G = C/O	

Table 6-1 ERROR LIST (Cont'd)

ERROR NO.	ERROR TYPE	CAUSE OF ERROR	REMEDY
211	Error during execution of the program.	The value of the function parameter is too large or too small. Example: T = SQR (–1)	Stops the execution.
212		The subrouting nesting has exceeded 10 levels.	
213		The return destination is lacking for the RETURN statement.	
214		Comparison cannot be made. Example: IF A = C GOTO 100	
215		The corresponding NEXT statement is lacking (the NEXT statement is inadequate).	
216		The corresponding FOR statement is lacking (the NEXT statement is excessive).	
217		The input data format is erroneous. Example: For INPUT C, D ? A, B	Inputs again. (Error level is W).
218		The input data is insufficient. Example: For INPUT C, D ? | –	
219		The input data is excessive. Example: For INPUT C, D ? 1, 2, 3	
221	Error during execution of the program	An input error has occurred on GP-IB.	Stops the execution.
222		An output error has occurred on GP-IB.	
223		The waiting time is smaller than 0. Example: J = –1 WAIT J	
224		The independent variable has a subscript. Example: INPUT E PRINT E (2)	

Table 6-1 ERROR LIST (Cont'd)

ERROR NO.	ERROR TYPE	CAUSE OF ERROR	REMEDY
225	Error during execution of the program	The array has no subscript. Example: DIM C (2) PRINT C	Stops the execution.
226		The subscript is out of boundary. Example: DIM C (5) PRINT C (5)	
227		The MS560J is the device, and execution is impossible.	
228		The MS560J is the controller, and execution is impossible.	
229		The program line to be executed is lacking. Example: 10 C = 0 20 PRINT C	
230		An attempt to refer to a system variable which cannot be referred to has been made. Example: C = CAL	
231		Substitution has been attempted into a system variable that cannot be substituted. Example: MOV = 0	
232		The subscript is not a numerical type. Example: DIM C (5) A = "A" C (A) = 0	

SECTION 7 PERSONAL TEST AUTOMATION APPLICATION PROGRAMS

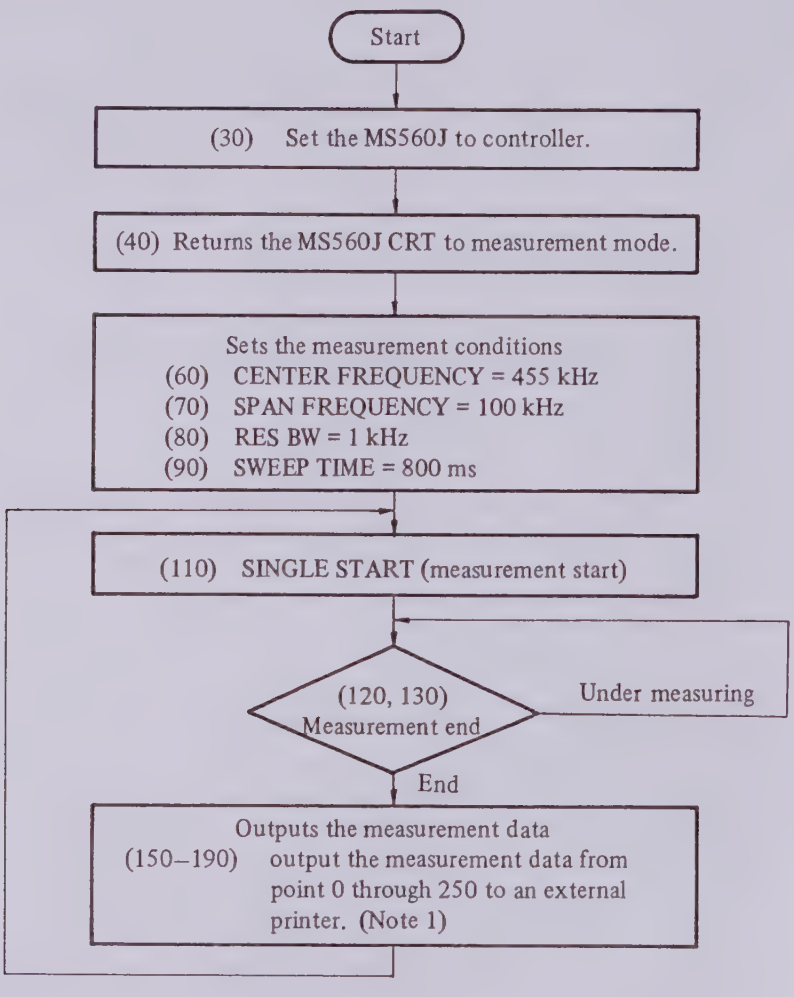
7.1 Basic Programming Techniques

Some basic programming techniques for the PTA system are shown in the following program and flowchart.

(a) Program

```
10 REM "** MS560J network analyzer **"
20 REM "MS560J is controler"
30 CALL ADR(32)
40 CALL CRTR(0)
50 REM "set measurement conditions"
60 FC1=100000
60 FC0=455000
70 FC1=100000
80 MRB=6
90 SWT=800
100 REM "start/end of measure"
110 CMS=1
120 WAIT 0.2
130 IF CMS=1 GOTO 110
140 REM "output of result"
150 FOR C=0 TO 250
160 FMAG=XA(C)
170 FMAG=FMAG*0.01
180 WRITE 17,C,F(C),FMAG
190 NEXT C
200 STOP
```

(b) Flowchart



Note

1. *This printer must be compatible with GP-IB.*
2. *The values in parentheses indicate program line numbers.*

7.2 Band Pass Filter Test

Tests a B.P.F. (Band Pass Filter) of 21.4 MHz in center frequency to measure the fixed loss, 3 dB band width, measured center frequency, ripple, and low and high range spurious, and displays the result on the CRT or prints it out. Moreover, the specified line of the B.P.F. will be displayed on the CRT.

(a) State of Measurement

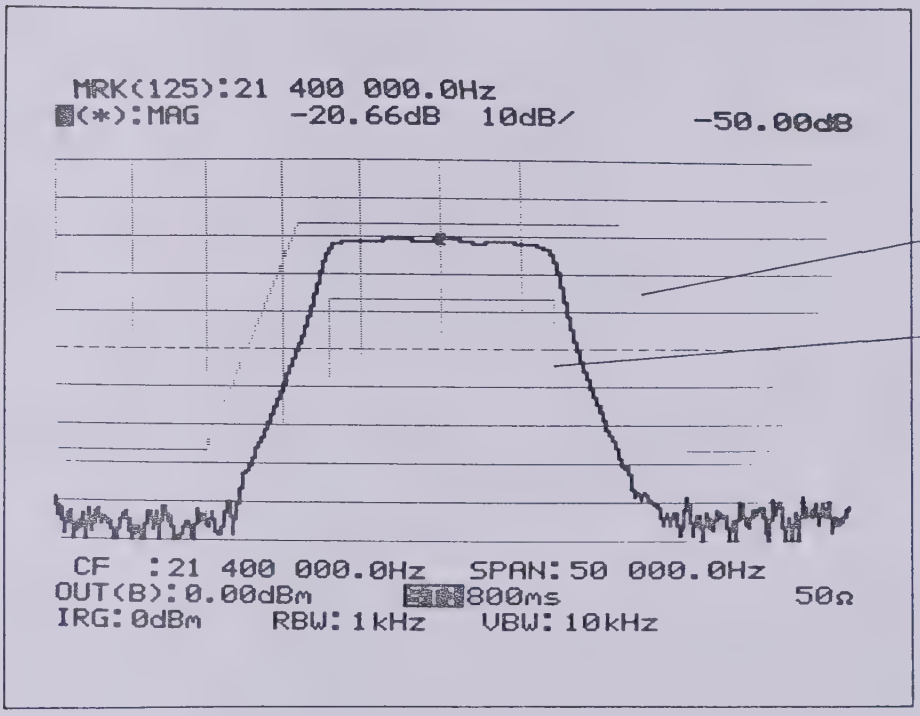


Fig. 7-1 CRT Display during Measurement

(b) Output

(1) CRT

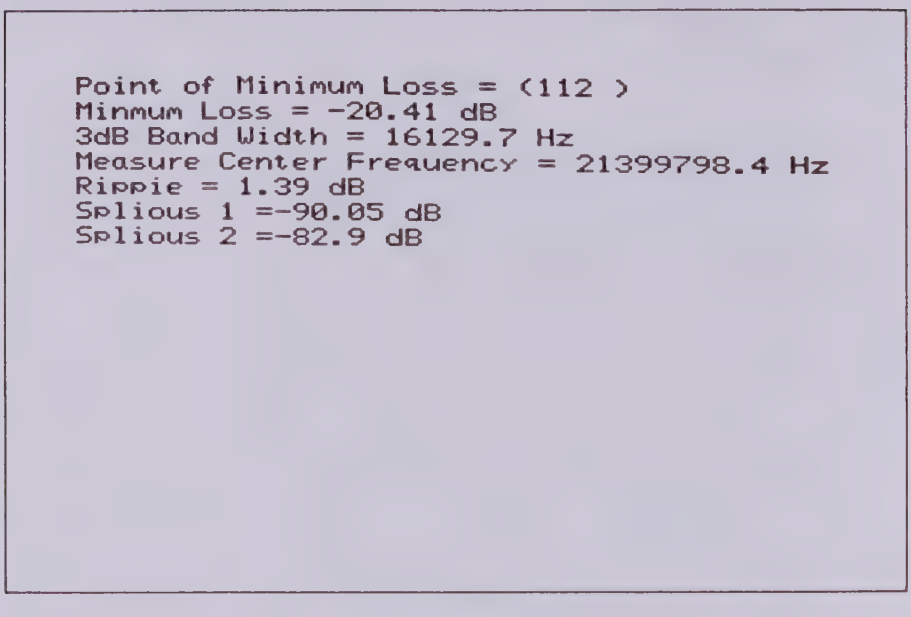


Fig. 7-2 CRT Display

(2) Printer

```
Point of Minimum Loss = (112 )
Minmum Loss = -20.44 dB
3dB Band Width = 16123.3 Hz
Measure Center Frequency = 21399817.8 Hz
Rippie = 1.41 dB
Splious 1 =-80.46 dB
Splious 2 =-84.74 dB
```

(c) Program

```
10 REM "MS560J Network/Spectrum Analyzer"
20 REM "Ceramic BPF (455kHz)"
30 REM "Set Measure Condition"
40 FC0=21400000
50 FC1=50000
60 MRB=6
70 SWT=800
80 CALL CRTR(0)
90 REM "Upper limit"
100 CALL CRTG(0,70,50,70,1)
110 CALL CRTG(50,70,80,160,1)
120 CALL CRTG(80,160,180,160,1)
130 CALL CRTG(180,160,200,70,1)
140 CALL CRTG(200,70,250,70,1)
150 REM "Lower Limit"
160 CALL CRTG(90,35,90,130,1)
170 CALL CRTG(90,130,160,130,1)
180 CALL CRTG(160,130,160,35,1)
190 REM "Measure Start/End"
200 CMS=1
210 WAIT 0.2
220 IF CMS=1 GOTO 210
230 REM "*** NET.ANA.FUNCTION ***"
240 REM "Minimum Loss ?"
250 LMX=MAX(C0,0,250,0)
260 GMX=LMX
270 GMX=GMX*0.01
300 FQL=BNDL(C1,C0,LSTD,0)
310 FQH=BNDH(C2,C0,LSTD,0)
320 FBD=FQH-FQL
330 REM "Measure Center Frequency ?"
340 FQC=FQL+FBD/2
350 REM "Ripple with 3dB Band ?"
360 GRPL=RPL1(C1,C2,0)
370 GRPL=GRPL*0.01
380 REM "Splious 1,2 ?"
390 LSTD=LMX-2000
400 LPLL=POLL(C3,C0,LSTD,0)
410 LPLL=POLH(C4,C0,LSTD,0)
420 GSP1=MAX(C5,0,C3,0)
425 GSP1=GSP1*0.01
427 GSP3=GSP1
430 GSP2=MAX(C6,C4,250,0)
435 GSP2=GSP2*0.01
440 REM "Check (S2)"
450 IF EX2=0 GOTO 480
460 GOSUB 1000
470 GOTO 490
480 GOSUB 2000
```

Excute WAIT statment for checking measurement end

(c) Program (Cont'd)

```
490 REM "Check (S1)"
500 IF EX1=0 GOTO 500
510 EX1=0
524 HOME
525 ERASE
526 WAIT 0.05
530 IF EX2=0 GOTO 80
540 HOME
550 CALL CRTC(0)
555 WAIT 0.05
560 GOTO 80
570 STOP
1000 REM "Output Printer"
1010 WRITE 0," "
1020 WRITE 0,"Point of Minimum Loss = ";
1030 WRITE 0,"(",C0,")"
1040 WRITE 0,"Minmum Loss = ",GMX,"dB"
1050 WRITE 0,"3dB Band Width = ",FBD,"Hz"
1060 WRITE 0,"Measure Center Frequency";
1070 WRITE 0," = ",FQC,"Hz"
1080 WRITE 0,"Rippie = ",GRPL,"dB"
1090 WRITE 0,"Splious 1 =",GSP1,"dB"
1100 WRITE 0,"Splious 2 =",GSP2,"dB"
1110 RETURN
2000 REM "Output Display"
2010 CALL CRTC(0)
2015 HOME
2020 PRINT " "
2030 PRINT "Point of Minimum Loss = ";
2040 PRINT "(",C0,")"
2050 PRINT "Minmum Loss = ",GMX,"dB"
2060 PRINT "3dB Band Width = ",FBD,"Hz"
2070 PRINT "Measure Center Frequency";
2080 PRINT " = ",FQC,"Hz"
2085 PRINT "Rippie = ",GRPL,"dB"
2090 PRINT "Splious 1 =",GSP1,"dB"
2100 PRINT "Splious 2 =",GSP2,"dB"
2110 RETURN
```

7.3 Program for Rapid Measurement (10 point measurement)

This program rapidly measures 10 points of magnitude, determines the validity of each result, and displays these results on the screen as shown in Fig. 7-3.

(a) CRT display

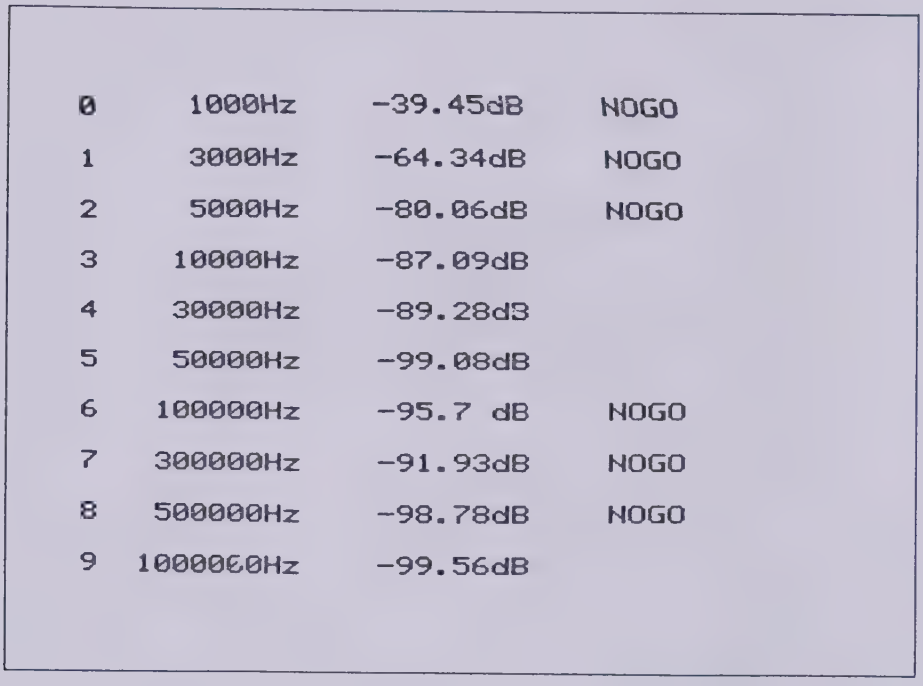


Fig. 7-3 CRT Display for 10 Point Measurement

(b) Program

```
10 REM "** 10 Points measurement **"
20 DIM GUL(10),GLL(10),AL(4)
30 REM "set measurement conditions"
40 DTR=0
50 MRB=6
60 MVB=7
70 SWT=1000
80 CBP=10
90 REM "inPut freqency,ul,ll"
100 C=0
110 HOME
120 ERASE
130 PRINT C," FREQ7ENCY (kHz)"
140 PRINT "  UL (dB)   LL(dB) ?"
150 INPUT FRQ,GUL(C),GLL(C)
160 F(C)=FRQ*1000
170 C=C+1
180 IF C<10 GOTO 110
190 HOME
200 ERASE
210 REM "start measure"
220 CMS=1
230 WAIT 0.05
240 IF CMS=1 GOTO 230
250 HOME
260 FOR C=0 TO 9
270 PRINT " "
280 GMAG=XA(C)
290 GMAG=GMAG*0.01
300 AL="    "
310 IF GMAG>GUL(C)LET AL="NOGO"
320 IF GMAG<GLL(C)LET AL="NOGO"
330 PRINT C:I2,F(C):I9,"Hz"
340 PRINT GMAG:F10.2,"dB","    ",AL
350 NEXT C
360 GOTO 220
```

7.4 Graphic Display

"アンリツ" (Japanese kana characters representing Anritsu) will be displayed on the CRT of the MS560J in the graphic mode.

(a) Display

Fig. 7-4 CRT Display

(b) Program

```
10 REM "Anritsu Function"
20 D1=22
30 D2=72
40 E=150
50 GOSUB 1000
60 D1=D1-1
70 D2=D2-1
80 IF D2>69 GOTO 50
90 D1=55
100 D2=69
110 E=141
120 GOSUB 1000
130 D1=D1-1
140 D2=D2-1
150 IF D2>64 GOTO 120
160 E=137
170 D1=30
180 D2=D1+14
190 GOSUB 1000
200 D1=D1-1
210 IF D1>20 GOTO 180
220 E=150
230 D1=77
240 D2=D1+14
250 GOSUB 1000
260 D1=D1-1
270 IF D1>73 GOTO 240
280 E=150
290 D1=125
300 D2=125
310 GOSUB 2000
320 D2=D2-1
330 D1=D1-3
340 IF D1>94 GOTO 310
350 E=130
360 D1=95
370 GOSUB 3000
380 D1=D1-3
390 IF D1>64 GOTO 370
400 E=150
410 D1=132
420 D2=D1+14
430 GOSUB 1000
440 D1=D1-1
450 IF D1>124 GOTO 420
460 E=150
470 D1=155
480 D2=D1+14
490 GOSUB 1000
500 D1=D1-1
```

(b) Program (Cont'd)

```
510 IF D1>140 GOTO 480
520 E=150
530 D1=173
540 D2=D1+9
550 GOSUB 1000
560 D1=D1-1
570 IF D1>168 GOTO 540
580 E=150
590 D1=186
600 D2=D1+9
610 GOSUB 1000
620 D1=D1-1
630 IF D1>181 GOTO 600
640 E=150
650 D1=202
660 D2=D1+14
670 GOSUB 1000
680 D1=D1-1
690 IF D1>187 GOTO 660
700 CALL CRTS(100,50,"Anritsu 50",1)
710 GOTO 710
720 STOP
1000 C=3
1010 CALL CRTG(D1,E,D2,E,0)
1020 E=E-1
1030 C=C-1
1040 IF C>0 GOTO 1010
1050 RETURN
2000 C=2
2010 D3=D1
2020 CALL CRTG(D3,E,D2,E,0)
2030 D3=D3-1
2040 E=E-1
2050 C=C-1
2060 IF C>0 GOTO 2020
2070 RETURN
3000 D3=D1
3010 C=2
3020 D2=D3+21
3030 CALL CRTG(D3,E,D2,E,0)
3040 D3=D3-1
3050 E=E-1
3060 C=C-1
3070 IF C>0 GOTO 3020
3080 RETURN
```

7.5 Totalization Program

This is a program for printing out bar graphs showing maximum, minimum, average, and disperse values of marks and their distribution.

(a) Program list

```
10 REM "Totalizer"
20 DIM CCLS(11)
30 REM "****** Initialize ******"
40 JMAX=-32767
50 JMIN=32767
60 TAVR=0
70 TDIS=0
80 FOR C=0 TO 10
90 CCLS(C)=0
100 NEXT C
110 WRITE 0,"Point"
200 REM "****** Input ******"
210 FOR C=0 TO 240 STEP 10
220 HOME
230 ERASE
240 PRINT "Key-in Point ( 0 to 100 ;";
250 PRINT " -1...end )"
260 FOR D=0 TO 9
270 INPUT JPON
280 IF JPON=-1 GOTO 470
290 IF JPON>=0 IF JPON<=100 GOTO 320
300 PRINT "Key-in Point again"
310 GOTO 270
320 IF JPON>JMAX LET JMAX=JPON
330 IF JPON<JMIN LET JMIN=JPON
340 TAVR=TAVR+JPON
350 TPON=JPON
360 TDIS=TDIS+TPON!2
370 CPON=JPON/10
380 CCLS(CPON)=CCLS(CPON)+1
390 WRITE 0,JPON:I4;
400 NEXT D
410 WRITE 0," "
420 NEXT C
430 PRINT "( full Points )"
440 WRITE 0,"( full Points )"
450 WAIT 3
460 GOTO 480
470 IF D><0 WRITE 0," "
480 C=C+D
490 IF C>0 GOTO 600
500 PRINT "( no Point )"
510 WRITE 0,"( no Point )"
520 STOP
```

(a) Program list (Cont'd)

```
600 REM "****** Print ******"
610 HOME
620 ERASE
630 WRITE 0," "
640 PRINT "Maximum =",JMAX:I4
650 WRITE 0,"Maximum =",JMAX:I4
660 PRINT "Minimum =",JMIN:I4
670 WRITE 0,"Minimum =",JMIN:I4
680 TAVR=TAVR/C+0.05
690 PRINT "Average =",TAVR:F6.1
700 WRITE 0,"Average =",TAVR:F6.1
710 TDIS=TDIS/C+0.05
720 TDIS=SQR(TDIS)-TAVR
730 PRINT "Dispers =",TDIS:F6.1
740 WRITE 0,"Dispers =",TDIS:F6.1
750 PRINT " "
760 WRITE 0," "
770 WRITE 0,"    ....*....1....*....2";
780 WRITE 0,"....*....3....*....4"
790 FOR C=0 TO 10
800 WRITE 0,C:I2,"x ";
810 IF CCLS(C)=0 GOTO 860
820 DE=CCLS(C)
830 FOR D=1 TO DE
840 WRITE 0,"*";
850 NEXT D
860 WRITE 0," "
870 NEXT C
880 WRITE 0," "
890 STOP
```

(b) Result

```
Point
  60  65  72  73  42  53  78  85  32  58
  95  67  62  84  42  31  24  71  53  97
  42 100  64  74  40  62  69  67

Maximum = 100
Minimum =  24
Average =  62.9
DisPers =   2.9

    ....*....1....*....2....*....3....*....4
 0x
 1x
 2x *
 3x **
 4x ****
 5x ***
 6x ********
 7x *****
 8x **
 9x **
10x *
```

7.6 I/O Port Control

Since the I/O port can be controlled by the Personal Test Language (PTL), the auto handler and trimming device are easily connected to the I/O port in the PTA system configuration.

All input and output signals through the I/O port use negative logic.

7.6.1 Explanation of I/O Port Signals

The names and specifications of the I/O port connector pins are shown in Table 7-1.

- GND (Pin 1)

  Ground line

- INPUT 1 (Pin 2)

  Pulse input pin. The input pulse (negative logic) sets tow internal filp-flop (F/F) circuits to low level (logical 1).

  One of F/F outputs is connected to OUTPUT 1 and the other is connected to OUTPUT 2.

  This signal can be mainly used to start a measurement by external control. The status of OUTPUT 1 and OUTPUT 2 which are called EX0 in PTA application programs, can be checked whether they are logical 1 or not by PTL statements.

  Therefore, for using the signal for external start control, the program must be written so that the processing flow changes by the EX0 content.

- OUTPUT 1 (Pin 3)

  Latch output pin. This is output of the internal F/F to be set by the pulse input to INPUT 1 or PTA application program.

  This signal is mainly used as the status output indicating that a measurement or data processing is in progress. The program must be written so that the internal F/F is reset upon termination of the measurement or data processing.

  The system variable EX0 is used to set and reset the internal F/F.

- OUTPUT 2 (Pin 4)

  Latch output pin. This is output of the internal F/F to be set by the pulse input to INPUT 1 or PTA application program.

  This signal is mainly used as the status output indicating that a measurement or data processing is in progress. The program must be written so that the internal F/F is reset upon termination of the measurement or data processing.

  The system variable EX0 is used to set and reset the internal F/F.

- Output Port A0 to A7 (Pins 5 to 12)

  Latch output pins. An 8-bit data can be output by a program. (No synchronizing or strobe signals can be output.).

  The system variable IA is used to output data to Output Port A.

- Output Port B0 to B7 (Pins 13 to 20)

  Latch output pins. An 8-bit data can be output by a program. (No synchronizing or strobe signals can be output.)

  The system variable IB is used to output data to Output Port B.

- I/O Port C0 to C3 (Pins 21 to 24)

  State input/latch output pins. This is a 4-bit I/O port. When this is set in the output mode, the write strobe signal (Pin 31) is output.

  The system variable IC is used to input/output the data.

  The system variable EIO is used to determine whether this port should be set in the input mode or output mode.

- I/O Port D0 to D3 (Pins 25 to 28)

  State input/latch output pins. This is a 4-bit I/O port. When this is set in the output mode, the write strobe signal (Pin 31) is output.

  The system variable ID is used to input/output the data.

  The system variable EIO is used to determine whether this port should be set in the input mode or output mode.

- Port C status (Pin 29)

  This is a status line which becomes HIGH when the I/O Port C is set in the input mode by the system variable EIO and becomes LOW when the I/O Port C is set in the output mode to externally indicate the current mode.

- Port D status (Pin 30)

  This is a status line which becomes HIGH when the I/O Port D is set in the input mode by the system variable EIO and becomes LOW when the I/O Port D is set in the output mode to externally indicate the current mode.

- Write strobe signal (Pin 31)

  Pulse output pin. A pulse is output from this pin when a data is output from either I/O Port C or D.

- N. C (Pins 32 and 33)

  Not connected.

- +5 V (Pin 34)

  The +5 V power supply line.

- X → S switching signal (Pin 35)

  This is an open collector output pin which is turned ON when the calibration function X → S is executed.

- +20 V (Pin 36)

  The +20 V power supply line.

Table 7-1 I/O port specifications

Pin No.	Name	Specifications	System variable name
1	GND	Ground	
2	INPUT 1	TTL level, negative logic, pulse input, pulse width $\geq 1\ \mu s$	EX0
3	OUTPUT 1	TTL level, negative logic, latch output	
4	OUTPUT 2	TTL level, negative logic, latch output	
5	Output port A0	TTL level, negative logic, latch output	IA
6	Output port A1	TTL level, negative logic, latch output	
7	Output port A2	TTL level, negative logic, latch output	
8	Output port A3	TTL level, negative logic, latch output	
9	Output port A4	TTL level, negative logic, latch output	
10	Output port A5	TTL level, negative logic, latch output	
11	Output port A6	TTL level, negative logic, latch output	
12	Output port A7	TTL level, negative logic, latch output	
13	Output port B0	TTL level, negative logic, latch output	IB
14	Output port B1	TTL level, negative logic, latch output	
15	Output port B2	TTL level, negative logic, latch output	
16	Output port B3	TTL level, negative logic, latch output	
17	Output port B4	TTL level, negative logic, latch output	
18	Output port B5	TTL level, negative logic, latch output	
19	Output port B6	TTL level, negative logic, latch output	
20	Output port B7	TTL level, negative logic, latch output	
21	I/O port C0	TTL level, negative logic, state input/ latch output	IC
22	I/O port C1	TTL level, negative logic, state input/ latch output	
23	I/O port C2	TTL level, negative logic, state input/ latch output	
24	I/O port C3	TTL level, negative logic, state input/ latch output	
25	I/O port D0	TTL level, negative logic, state input/ latch output	ID
26	I/O port D1	TTL level, negative logic, state input/ latch output	
27	I/O port D2	TTL level, negative logic, state input/ latch output	
28	I/O port D3	TTL level, negative logic, state input/ latch output	
29	Port C status	TTL level, input mode: HIGH, output mode: LOW	EIO
30	Port D status	TTL level, input mode: HIGH, output mode: LOW	
31	Write strobe signal	TTL level, negative logic, pulse output, pulse width 250 ns	(Note)
32	N・C		
33	N・C		
34	+5 V	Max. 100 mA	
35	X → S switching signal	Open collector	
36	+20 V	Max. 100 mA	

Note: Pulses are generated when a data is output from I/O ports C and D.

7.6.2 System Variables for Accessing I/O Ports

The system variable is a combination of a PTL variable and each of the many functions of MS560J. The specified function is set by assigning the specified value to the system variable in the program. The setting status of the function and the measured value can be obtained by reading the contents of the system variable.

The following six system variables are used in connection with the I/O ports:

EX0
IA
IB
IC
ID
EIO

The system variables are described below. STORE in the description means an assignment to the system variable and LOAD means reading of a data from the system variable.

- EX0 . . . . . This system variable is used to access the internal F/F of OUTPUT 1 and OUTPUT 2. The variable type is a single precision integer. The meanings of the data for accessing EX0 are as shown in Table 7-2.

Table 7-2 Accessing EX0

Data	LOAD	STORE
0	OUTPUT 1 F/F is reset.	OUTPUT 1 F/F reset OUTPUT 2 F/F reset
1	OUTPUT 1 F/F is set.	OUTPUT 1 F/F set OUTPUT 2 F/F reset
2		OUTPUT 1 F/F reset OUTPUT 2 F/F set
3		OUTPUT 1 F/F set OUTPUT 2 F/F set

- IA . . . . . This system variable is used to output 8-bit data to Output Port A. The variable type is bit.

- IB . . . . . This system variable is used to output 8-bit data to Output Port B. The variable type is bit.

- IC . . . . . This system variable is used to input/output 4-bit data to and from I/O Port C. The variable type is bit. The system variable EIO is used to switch the input/output mode.

- ID . . . . . This system variable is used to input/output 4-bit data to and from I/O Port D.
  The variable type is bit.
  The system variable EIO is used to switch the input/output mode.

- EIO . . . . . This system variable is used to set I/O Ports C and D either in the input mode or output mode.
  The variable type is a single precision integer.
  The meanings of the data for accessing EIO are as shown in Table 7-3.

Table 7-3 Accessing EIO

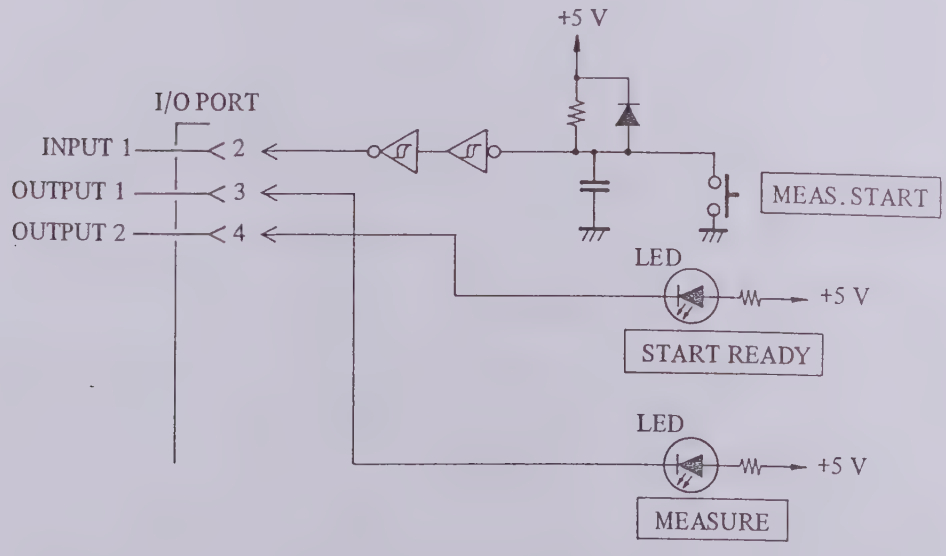
Data	STORE
0	I/O port C: Input I/O port D: Input
1	I/O port C: Output I/O port D: Input
2	I/O port C: Input I/O port D: Output
3	I/O port C: Output I/O port D: Output

7.6.3 Application Examples

(1) INPUT 1, OUTPUT 1 and OUTPUT 2

An example where INPUT 1 is used as an input for measurement start (MEAS. START), OUTPUT 1 to indicate that a measurement and data processing are in progress, and OUTPUT 2 as an indicator for measurement start wait is shown below.

< Circuit example 1 >



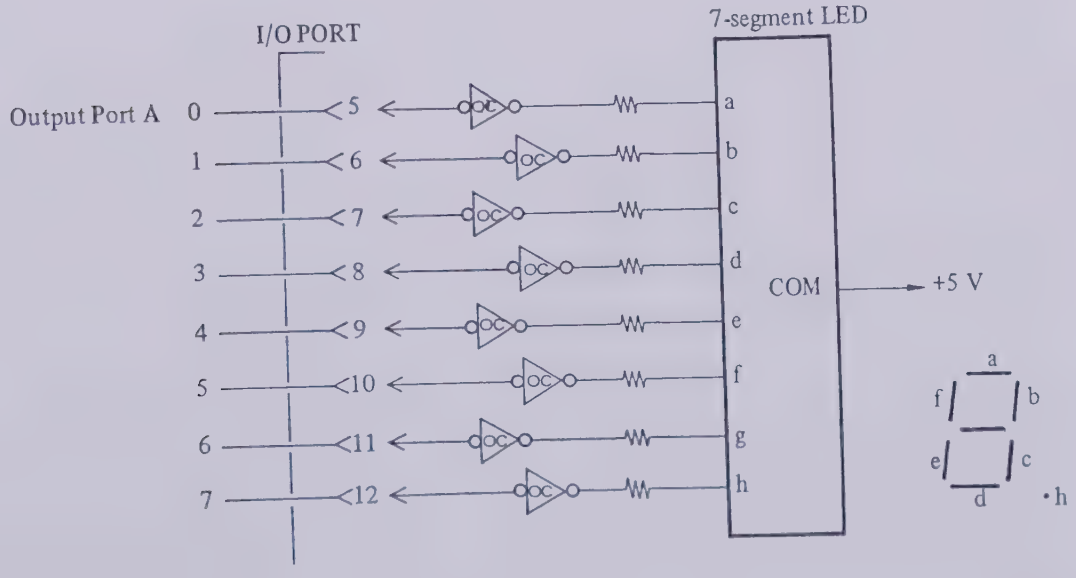
<Program example 1>

```
10   EX0 = 0
 ⋮    ⎫
     Measurement preparation routine
 ⋮    ⎭
100  EX0 = 2 ........ START READY lamp ON.

110  C = EX0                    }
                                }  Wait for MEAS. START switch to be pressed.
120  IF C < > 1 GOTO 110        }

130  EX0 = 1 ........ START READY lamp OFF, MEASURE lamp ON.
 ⋮    ⎫
     Measurement and data processing routines
 ⋮    ⎭
200  EX0 = 0 ........ MEASURE lamp OFF.

210  STOP
```

(2) Output Port A or Output Port B

An example where a 7-segment digital display LED is connected to Output Port A for displaying numerics is shown below.

<Circuit example 2>



＜Program example 2＞

An example program where 0 to 9 are displayed each time the MEAS. START switch shown in ＜Circuit example 1＞is pressed is shown below.

```
10  DIM D (9)
20  D (0) = $5C
30  D (1) = $06
40  D (2) = $5B
50  D (3) = $4F
60  D (4) = $66
70  D (5) = $6D
80  D (6) = $7D
90  D (7) = $27
100 D (8) = $7F
110 D (9) = $6F
120 IA = $0 . . . . . .LED OFF
130 N = 0
140 EX0 = 0
150 C = EX0
160 IF C < > 1 GOTO 150
170 IA = D (N) . . . . . .Display output
180 N = N + 1
190 IF N = < 10 GOTO 140
200 STOP
```

Definition of LED segment data

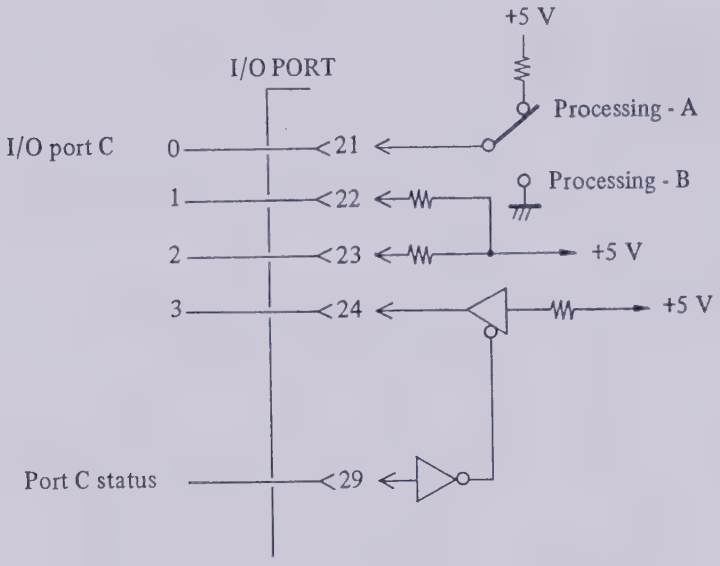
Definition of LED segment data

Checking the MEAS. START switch

(3) I/O Port C or I/O Port D

An example where the processing routine is changed depending on whether bit 0 of I/O Port C is 0 or 1 is shown below.

< Circuit example 3 >



< Program example 3 >

An example where a switch is set for processing A or processing B, and where Port C is checked and the processing is branched by pressing the MEAS. START switch shown in < Circuit example 1 > is shown below.

```
10   EIO = 0

20   EX0 = 0

30   C = EX0

40   IF C <> 1 GOTO 30

50   D = IC

60   IF D = 1 GOTO 200
 :     }
     Processing A
 :     }
100  STOP

200  REM
 :     }
     Processing B
 :     }
250  STOP
```

(4) Program for outputting double precision real numbers to I/O port (port C, D)

- Sample program

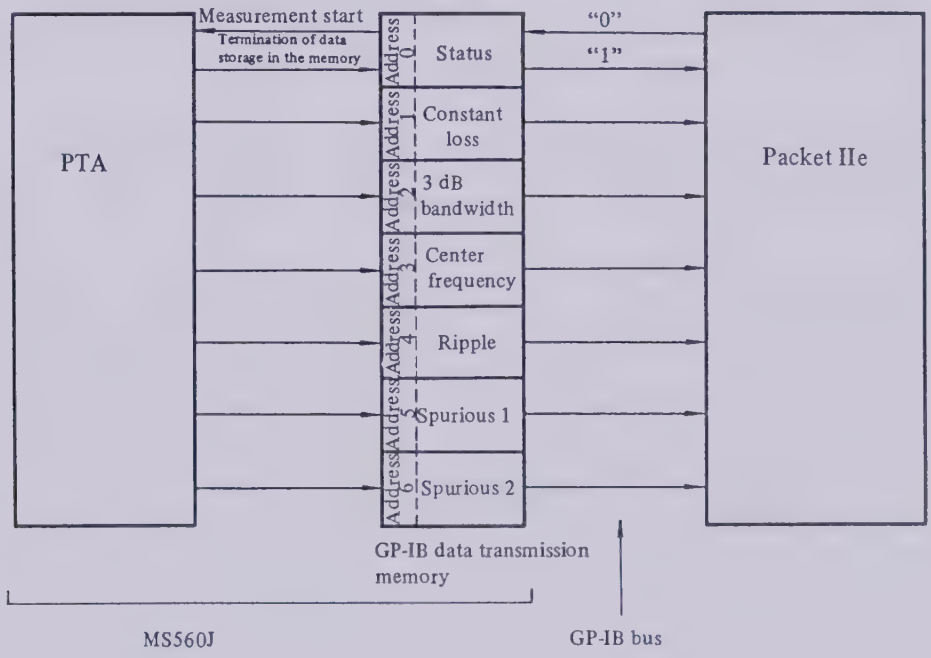
```
10 EIO=1                    ; Port C becomes an output port and port D becomes
                              an input port.
20 GN=12345
30 GR=10000
40 FOR C=0 TO 4
50 D=GN/GR
60 IC=D                     ; Real numbers 1, 2, 3, 4, and 5 are output in this order
                              to port C, and the write strobe signal is output simulta-
                              neously.
70 GN=GN-GR*D
80 GR=GR/10
90 NEXT C
100 STOP
```

7.7 How to Control the PTA System With A Personal Computer

Generally, a personal computer reads the data measured by the measuring device through GP-IB, processes it to the final data type requested by the user, and outputs it. If a device which must process many measurement points (such as a network or spectrum analyzer) is used with this method, a lot of time is required for the data transmission.

PTL enables the PTA to process measurement data rapidly into the final data type requested by the user. By reducing the amount of this processed data to be transferred, data transmission time can also be reduced. The following program obtains evaluation parameters of the band pass filter (constant loss, 3 dB bandwidth, etc.) in PTA and transfers them to an Anritsu Packet IIe Personal Technical Computer via a GP-IB data transmission memory.

The GP-IB data transmission memory map and data flow for this program are shown below.



(a) PTA application program

The following program is filed in the floppy disk of a Packet IIe Personal Technical Computer in accordance with the procedure explained in paragraph 3.4.2 (1).

```
10 REM "MS560J Network/Spectrum Analyzer"
20 REM "Ceramic BPF (455kHz)"
30 REM "Set Measure Condition"
40 FC0=455000
50 FC1=100000
60 MRB=6
70 SWT=800
80 CALL CRTR(0)
90 WRITE 0,"0"
100 READ 0,C
110 IF C<>0 GOTO 100
120 REM "Measure Start/End"
130 CMS=1
140 WAIT 0.2
150 IF CMS=1 GOTO 140
160 REM "*** NET.ANA.FUNCTION ***"
170 REM "Minimum Loss ?"
180 LMX=MAX(C0,0,250,0)
190 GMX=LMX
200 GMX=GMX*0.01
210 FQL=BNDL(C1,C0,LSTD,0)
220 FQH=BNDH(C2,C0,LSTD,0)
230 FBD=FQH-FQL
240 REM "Measure Center Frequency ?"
250 FQC=FQL+FBD/2
260 REM "Ripple with 3dB Band ?"
270 GRPL=RPL1(C1,C2,0)
280 GRPL=GRPL*0.01
290 REM "Splious 1,2 ?"
300 LSTD=LMX-2000
310 LPLL=POLL(C3,C0,LSTD,0)
320 LPLL=POLH(C4,C0,LSTD,0)
330 GSP1=MAX(C5,0,C3,0)
340 GSP1=GSP1*0.01
350 GSP3=GSP1
360 GSP2=MAX(C6,C4,250,0)
370 GSP2=GSP2*0.01
380 WRITE 1,GMX
390 WRITE 2,FBD
400 WRITE 3,FQC
410 WRITE 4,GRPL
420 WRITE 5,GSP1
430 WRITE 6,GSP2
440 WRITE 0,"1"
450 GOTO 100
```

Sets measurement conditions.

Waits until 0 is set in address 0 of the GP-IB data transmission memory by the personal computer.

Starts measuring.

Stores the constant loss in address 1 of the GP-IB data transmission memory.

Stores the 3dB bandwidth in address 2 of the GP-IB data transmission memory.

Stores the center frequency in address 3 of the GP-IB data transmission memory.

Stores the ripple in address 4 of the GP-IG data transmission memory.

Stores spurious 1 (low range) in address 5 of the GP-IB data transmission memory.

Stores spurious 2 (high range) in address 6 of the GP-IB data transmission memory.

The personal computer reads data stored in address 1 through 6 by setting 1 in address 0 of the GP-IB data transmission memory.

(b) Packet IIe program for PTA system control

The required PTA application programs must be filed in the Packet II floppy disk before beginning the measurement.

```
 10 REM ***** PTA SYSTEM *****
 20 DIM A$*42
 30 WRITE @101:"PT1"
 40 WRITE @101:CHR$(4)
 50 OPEN #1:NAME "PTA"
 60 LINE INPUT #1:A$
 70 IF A$="END" THEN 90
 80 WRITE @101:A$*GO TO 60
 90 CLOSE #1
100 WRITE @101:CHR$(3)
110 WRITE @101:CHR$(5)
120 WRITE @101:"RUN"
130 WRITE @101:CHR$(6)*WAIT DELAY 1
140 REM
150 WRITE @101:"MYR0,1"
160 WAIT DELAY .5*READ @101:A$
170 IF A$="0" THEN 150
180 REM
190 WRITE @101:"MYR1,6"
200 READ @101:A$*PRINT "minimum loss = ";A$
210 READ @101:A$*PRINT "3dB band width = ";A$
220 READ @101:A$*PRINT "center frequency = ";A$
230 READ @101:A$*PRINT "ripple = ";A$
240 READ @101:A$*PRINT "splious 1 = ";A$
250 READ @101:A$*PRINT "splious 2 = ";A$
260 WRITE @101:"MY0,0"
270 GO TO 140
280 END
```

Sets PTA to ON.

Loads the PTA application program from the floppy disk and transfers it to the MS560J.

Executes the PTA application program.

Waits until 1 is set in address 0 and data is stored in address 1 through 6 of the GP-IB data transmission memory.

Reads data stored in address 1 through 6 of the GP-IB data transmission memory.

Sets 0 in address 0 of the GP-IB data transmission memory so that the PTA will perform the next series of measurements.

APPENDIX-1 BASIC STATEMENT EXECUTION TIME (1)

ITEM NO.	ITEM		EXECUTING TIME (mS)	REMARKS
1	REM statement		0.3	
2	DIM statement		0.9N + 0.1	N: Number of variable
3	GOTO statement		1.6	
4	GOSUB, RETURN statement		1.9	
5	STOP statement		10.1	±2.0 mS
6.1	IF statement	Integer	0.7	Each executing time listed left is available when condition expression is false. If the condition expression is true, then the executing time of dependent statement: −0.2 mS If numeric constants are specified in integer or Real, then the executing time: +1.0 ms.
6.2		Double Precision Integer	0.8	
6.3		Real	0.9	
6.4		Double Precision Integer	1.0	
6.5		Letter (one letter)	0.6	
6.6		Letter (≧two letter)	0.7	
6.7		Bit	0.7	
7.1	FOR, NEXT statement	Integer	0.8	
7.2		Double Precision Integer	0.9	If incremented values are defaulted, then the executing time: +0.1 ms.
7.3		Real	1.2	
7.4		Double Precision Integer	1.4	
8	HOME statement		2.4	
9.1	ERASE statement	Home position	9.8	
9.2		Others	538.1N +4.9	N: Number line.
10	PRINT statement		Addition of output item: +5.2 Integer = 6.4 Real = 16.1 Double Precision Real = 4.7 Letter = 4.1 Bit = 6.4	
11	LET statement		Calculation for addition: substitutes + into LET statement. See next page for details	
12	INPUT statement		——	
13	READ statement WRITE statement		Depends on the device	

APPENDIX-2 BASIC STATEMENT EXECUTION TIME (2)

LET Statement substitution time (ms)

Item	Integer	Double Precision Integer	Real	Double Precision Real	Letter Type	Bit Type	Constant
Integer	0.7	0.8	0.8	1.3	0.7	0.7	1.5
Double Precision Integer	0.8	0.6	0.8	1.7			1.8
Real	0.8	0.8	0.7	8.6			8.8
Double Precision Real	2.0	2.1	9.6	0.7			0.9
Letter type	0.7				0.7	0.7	0.7
Bit type	0.7				0.7	0.7	0.6

LET Statement Operation time (ms)

Item \ Operator	+	–	*	/	!	Constant
Integer	0.4	0.5	0.5	0.7	5.4	+0.8
Double Precision Integer	0.6	0.6	0.5	0.7	5.5	+1.2
Real	0.7	0.6	0.7	0.7	5.2	+8.1
Double Precision Real	0.7	0.8	4.3	8.6	37.9	+0.2

APPENDIX-3 A LIST OF PTL FUNCTIONS

Item number	Item			Format
1.1	Command	Delete		DELETE [line number 1] [, [line number 2]]
1.2	Command	List		LIST [line number 1] [, [line number 2]]
				LISTG address, [line number 1] [, [line number 2]]
1.3	Command	Renumber		RENUM [new line number [, increment [, old line number]]]
1.4	Command	Execution start		RUN [start line number] [, suspension line number]
1.5	Command	Execution continue		CONT [suspension line number]
1.6	Command	Save		SAVE program name
1.7	Command	Load		LOAD program name
1.8	Command	Program name list		PLIST
2.1	Statements	Comment		REM ["comment"]
2.2	Statements	Array declaration		DIM variable name (array size) [, variable name (array size) . . .]
2.3	Statements	Substitution		[LET] variable = expression
2.4	Statements	Branch		GOTO line number
2.5	Statements	Branch to subroutines		GOSUB line number
2.6	Statements	Return from subroutines		RETURN
2.7	Statements	Decision		IF variable = variable (or constant) statement
2.8	Statements	Repetition start		FOR numeric variable = initial value TO ending value [STEP increment]
2.9	Statements	Repetition termination		NEXT numeric variable
2.10	Statements	Key input		INPUT variable [format] [, variable [format] . . .]
2.11	Statements	Display		PRINT variable [format] [, variable [format] . . .] [;]
2.12	Statements	Home position		HOME
2.13	Statements	Erase		ERASE
2.14	Statements	Wait		WAIT constant
2.15	Statements	GP-IB input		READ address, variable [format] [, variable [format] . . .]
2.16	Statements	GP-IB output		WRITE address, variable [format] [, variable [format] . . .] [;]
2.17	Statements	System subroutine execution		CALL system subroutine name [(parameter (, parameter . . .))]
3.1	System subroutines	Screen clear		CRTC (N)
3.2	System subroutines	Screen restoration		CRTR (N)
3.4	System subroutines	Character string display		CRTC (X, Y, string, N)
3.5	System subroutines	Graphics display		CRTG (X0, Y0, X1, Y1, N)
3.6	System subroutines	IFC		IFC
3.7	System subroutines	SRQ output		RSV
3.8	System subroutines	Address modification		ADR (N)
3.9	System subroutines	Buzzer		BZR
4.1	Functions	Arithmetic functions		SIN, COS, TAN, ASN, ACS, ATN, LN, LOG, EXP, SQR, ABS, SGN
4.2	Functions	Boolean functions		NOT, AND, OR, NOR
4.3	Functions	System functions	Maximum value	MAX (maximum value point, starting point, terminating point, memory area)
			Minimum value	MIN (minimum value point, starting point, terminating point, memory area)
			Cut frequency 1	BNDL (designated measured-value point, search start point, designated measured-value, memory area)
			Cut frequency 2	BNDH (designated measured-value point, search start point, designated measured-value, memory area)
			Ripple 1	RPL1 (starting point, terminating point, memory area)
			Ripple 2	RPL2 (inflection point number, starting point, terminating point, memory area)
			Pole 1	POLL (low range pole point, starting point, designated attenuation, memory area)
			Pole 2	POLH (high range pole point, starting point, designated attenuation, memory area)

APPENDIX-4 A List Of Variable Types And Alphabetic Character Strings That Cannot Be Defined As Variables

Item number	Item	Single precision integer type	Double precision integer type	Single precision real number type	Double precision real number type	Character type	Bit type
1	Range	1 byte 0 ~ 255	2 bytes -32768 ~ +32767	4 bytes 7 digits, $10^{-20} - 10^{18}$	8 bytes 14 digits, $10^{-14} - 10^{13}$	1 byte per character Maximum: 128 characters	1 byte 8 bits
2	Type declaration	C _ _ _ D _ _ _ E _ _ _ M _ _ _ N _ _ _ O _ _ _ P _ _ _ Q _ _ _ R _ _ _	J _ _ _ K _ _ _ L _ _ _ X _ _ _	T _ _ _ U _ _ _ V _ _ _ W _ _ _ Y _ _ _ Z _ _ _	F _ _ _ G _ _ _ H _ _ _ S _ _ _	A _ _ _ B _ _ _	I _ _ _
3	Alphabetic character strings that cannot be defined.	CALL, CONT COS, CRTC CRTR, CRTS CRTG, DIM EOR, EXP MAX, MIN NEXT, NOT OR, POLL POLH, READ REM, RPL1 RPL2, RSV, RUN, CAM, CIT CAL, CMS, CME, CBP, CMP CSM, CBZ, DTR, DLN, DEX DST, DSA, DSB, DZO, DDK DMK, DMP, EX0, EX1, EX2 EIO, MF0, MF1, MLW, MTK MCF, MCP, MXS, MTA, MTV MIR, MRB, MVB, MDR, MOP MIM, MOV, MUC, MIG, MMH MFC, MOM	LN, LOG, L(*) LV0, LV1, LV2 XA(*), XB(*) XSA(*), XSB(*) XTG, XOA XOB, LOAD	TAN, TO, WAIT	GOTO, HOME, SAVE SGN, SIN, SQR STEP, STOP, F(*) FC0, FC1, FS0, FS1 FFC, FOF, SWT, SCT	ABS, ACS, ASN, ATN	IA, IB, IC, ID

Anritsu

OPERATION MANUAL

MS560J

GP-IB INTERFACE

ANRITSU CORP.

1985.10 x 60 NIII-4(Y)
Printed in Japan

CERTIFICATION

Anritsu Electric Co., Ltd. certifies that this instrument has been thoroughly tested and inspected, and found to meet published specifications prior to shipping.
Anritsu further certifies that its calibration measurements are based on the Japanese Electrotechnical Laboratory and Radio Research Laboratory standards.

WARRANTY

All Anritsu products are warranted against defects in material and workmanship. The warranty is effective for one year from the date of delivery. In the event of improper use, abuse, or damage due to natural catastrophe, the warranty will become void. Anritsu will repair or replace products which prove to be defective during the warranty period, provided they are returned to Anritsu.
No other warranty is expressed or implied.
All requests for repairs and replacement parts should be directed to Anritsu or its representative in your area.

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NOTICE

Anritsu changed its name from Anritsu Electric Co., Ltd. to ANRITSU CORP.
The new name is effective from October 1st 1985. Please change the old name to the new name in this manual.

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SECTION 1 GENERAL

The GP-IB (General Purpose Interface Bus) interface is provided as standard equipment with the MS560J Network/Spectrum Analyzer.

The GP-IB is a standard interface bus specified in IEEE-488 (Institute of Electrical and Electronics Engineers) and IEC-625 (International Electrotechnical Commission).

GP-IB enables all MS560J functions, except the POWER switch, to be remotely controlled. In addition, the CRT can be used as a character/graphics terminal in personal computer systems. Thus, by connecting the MS560J to a personal computer or another measuring device, a flexible system can easily be configured.

Since the MS560J is capable of functioning as a GP-IB controller, the MS560J can print out measurement results and handle frequency offset tracking with a synthesizer.

Moreover, by adding the Personal Test Automation 1 (PTA1) option, flexible systems can be configured without personal computer.

For details on GP-IB, ask your dealer or representative for a copy of the "INTRODUCTION TO GP-IB SYSTEMS".

Note: 1. *The reader will be able to understand the contents of this manual more easily by starting with SECTION 8 EXAMPLE PROGRAMS.*
2. *The MS560J Network/Spectrum Analyzer Operation Manual and Packet IIe Personal Technical Computer Operation/Reference Manual should be used for reference.*

SECTION 2 GP-IB FUNCTIONS

The GP-IB functions of the MS560J Network/Spectrum Analyzer are shown below.

2.1 GP-IB Functions as Talker/Listener

SH1	..... Source handshake function provided
AH1	..... Accept handshake function provided
T6	..... Talker function provided, talk only function not provided
L4	..... Listener function provided, listen only function not provided
SR1	..... Serial polling function provided
RL1	..... Remote/local function provided
PP0	..... Parallel polling function not provided
DC0	..... Device clear function not provided
DT0	..... Device trigger function not provided

2.2 GP-IB Controller Functions

C1	Response function for SRQ not provided, controller transmission function not provided.
C3	
C28	

For switching between controller and talker/listener functions, see SECTION 3, CP-IB ADDRESSES.

SECTION 3 GP-IB ADDRESSES

3.1 GP-IB ADDRESSES

The GP-IB has addresses for each device. Listener and talker are specified by MLA (My Listen Address) or MTA (My Talk Address) from the controller.

The device is usually provided with dip switches or a rotary switch either inside the device or on the rear panel, for modifying addresses as required.

GP-IB addresses are represented by bits 1 to 5 of the DIO line. The relationship between GP-IB address commands and ASCII codes is given in Table 3-1.

In the MS560J Network/Spectrum Analyzer, the address switch is mounted on the GP-IB PC board. The address set by this switch is enabled when power is turned on.

In addition, addresses can be verified and modified from the keys on the front panel by using the ADV FUNCTION.

Table 3-1 Relationship between address commands and ASCII codes

	Listen address command			Talk address command		
	b8	b7	b6	b8	b7	b6
b5 b4 b3 b2 b1	0	0	1	0	1	0
0 0 0 0 0	(SPACE)			@		
0 0 0 0 1	!			A		
0 0 0 1 0	"			B		
0 0 0 1 1	#			C		
0 0 1 0 0	$			D		
0 0 1 0 1	%			E		
0 0 1 1 0	&			F		
0 0 1 1 1	'			G		
0 1 0 0 0	(			H		
0 1 0 0 1	)			I		
0 1 0 1 0	*			J		
0 1 0 1 1	+			K		
0 1 1 0 0	,			L		
0 1 1 0 1	–			M		
0 1 1 1 0	.			N		
0 1 1 1 1	/			O		
1 0 0 0 0	0			P		
1 0 0 0 1	1			Q		
1 0 0 1 0	2			R		
1 0 0 1 1	3			S		
1 0 1 0 0	4			T		
1 0 1 0 1	5			U		
1 0 1 1 0	6			V		
1 0 1 1 1	7			W		
1 1 0 0 0	8			X		
1 1 0 0 1	9			Y		
1 1 0 1 0	:			Z		
1 1 0 1 1	;			[		
1 1 1 0 0	<			\		
1 1 1 0 1	=			]		
1 1 1 1 0	>			↑		
1 1 1 1 1	? (UNL)			– (UNT)		

UNL: Unlisten command
UNT: Untalk command

3.2 Modifying GP-IB Address with Address Switch

Figure 3-1 shows the locations of the PC board and the address switches for GP-IB.

The GP-IB PC board can be extracted after removing the top cover of the MS560J.

Figure 3-2 shows details of the address dip switches. Address bits A1 to A5 must be set appropriately, and switch 8 must be set to DEVICE (ON) when using MS560J as a talker/listener.

When using MS560J as a controller, set switch 8 to CONTROLLER (OFF), leaving switches 6 and 7 off. When power is turned on, MS560J is set as a controller.

At the factory, MS560J is set as shown in Figure 3-2 (address is 1).

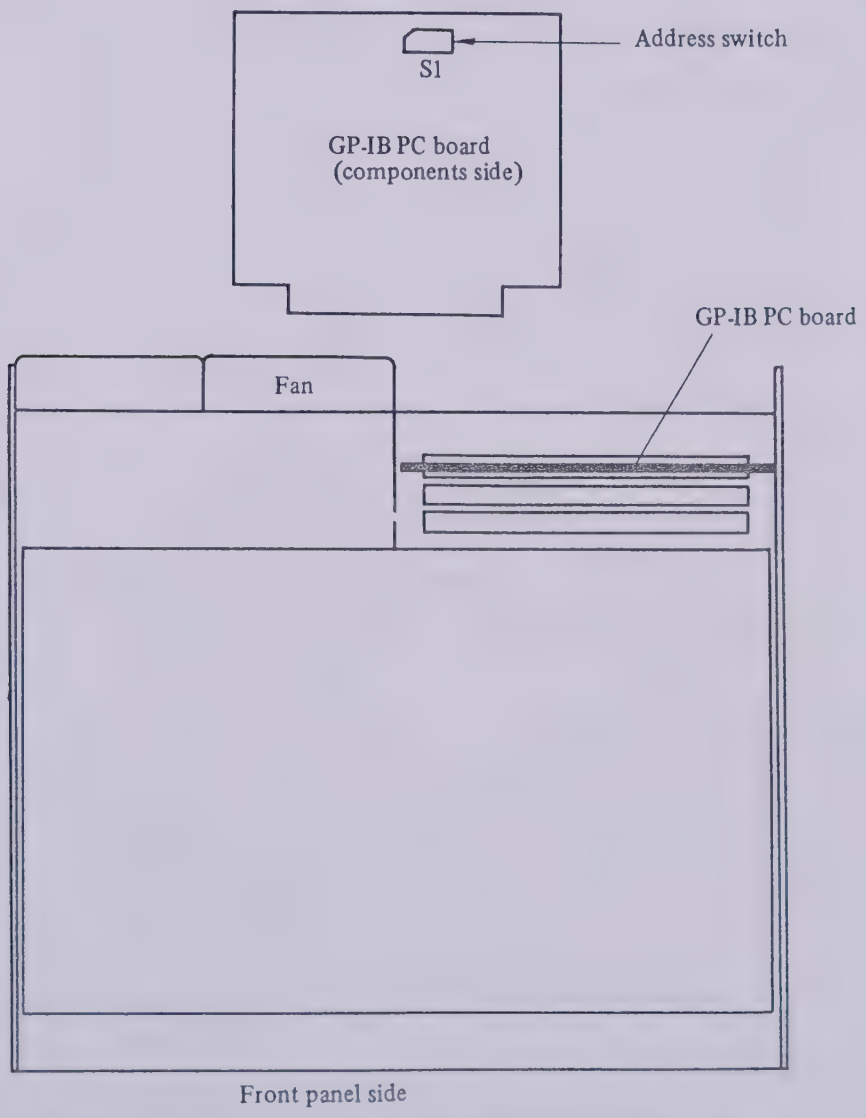


Fig. 3-1 Location of GP-IB PC board and address switches (top view)

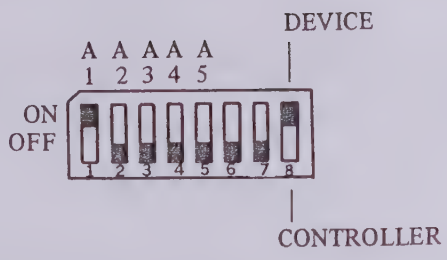


Fig. 3-2 Address switches

3.3 Modifying GP-IB Address with Front Panel Keys

GP-IB addresses can be verified and modified with the front panel keys. The GP-IB COMMAND of the ADV FUNCTION is used for verifying and modifying the addresses. For details on the ADV FUNCTION, refer to ADV FUNCTION in paragraph 2.8-(35) of the MS560J Network/Spectrum Analyzer Operation Manual.

3.3.1 GP-IB address verification

(1) Call ADV line of the GP-IB COMMAND

Press keys [BEGIN] [/] [1] [0] [EOL] in this order.

```
1 0  GP-IB COMMAND
```

(2) Press keys [A] [D] [R] [?] [EOL] in this order.

```
1 0  GP-IB COMMAND     ADR?
```

(3) GP-IB address is displayed on the line above the ADV line.

```
        GP-IB ADDRESS(1)
1 0  GP-IB COMMAND     ADR?
```

Note: To verify the GP-IB address again, repeat step (2). The SYNTAX ERROR message will be displayed if only [EOL] key is pressed in step (3).

3.3.2 GP-IB address modification

(1) To modify addresses, press keys [A] [D] [R] [9] [EOL] in this order.

```
1 0  GP-IB COMMAND     ADR9
```

(2) The modified address is displayed on the line above the ADV Line.

```
        GP-IB ADDRESS(9)
1 0  GP-IB COMMAND     ADR9
```

The correspondence of keys and GP-IB addresses is given in Table 3-2.

Note: To modify the GP-IB address again, repeat step (1). The SYNTAX ERROR message will be displayed if only [EOL] key is pressed in step (2).

Table 3-2 Correspondence of address set keys and addresses

Address	Address set key	Address	Address set key
0	[0]	16	*1
1	[1]	17	[A]
2	[2]	18	[B]
3	[3]	19	*2
4	[4]	20	[D]
5	[5]	21	[E]
6	[6]	22	[F]
7	[7]	23	[G]
8	[8]	24	[H]
9	[9]	25	[I]
10	[:]	26	[J]
11	[;]	27	[K]
12	[<]	28	[L]
13	[=]	29	[M]
14	[>]	30	[N]
15	*1		

*1: No address set keys are provided.
*2: Key for setting MS560J as a controller is used.

3.3.3 Procedure for setting the MS560J to controller

(1) To use the MS560J as a controller, press keys [A] [D] [R] [C] [EOL] in this order

```
1 0  GP-IB COMMAND     ADRC
```

(2) The following appears on the line above the ADV Line.

```
        GP-IB CONTROLLER
1 0  GP-IB COMMAND     ADRC
```

Note: See the note in paragraph 3.3.2.

SECTION 4 DEVICE MESSAGES

4.1 Explanation of MS560J Device Messages

Device messages are commands for controlling the MS560J and data transmission by the MS560J. There are two types of device messages: control messages for controlling MS560J and data request messages for reading data from the MS560J.

Figure 4-1 is a diagram of MS560J device message syntax.

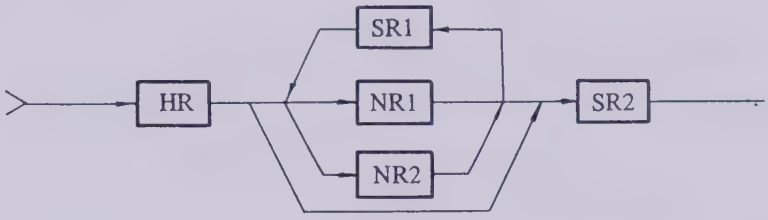


Fig. 4-1 Device message syntax

(1) Header (HR) field

The HR field indicates the type and contents of the data, and appears at the head of the device message. In the MS560J, the HR field is represented by two or three uppercase letters corresponding to the function indicated on the front panel. If undefined HR is used in a device message, this device message is ignored.

(2) Numeric (NR) field

The NR field is a data field indicating numeric values. There are two formats:

- NR1 format: Integer
- NR2 format: Real number

(3) Separator (SR) field

The SR field is a separator symbol field indicating the end of a data value or a message. When several messages are transmitted sequentially, the SR field is inserted between the messages to indicate the end of each message transmission and the start of the subsequent message.
There are two types of SR fields:

- SR1 type: Comma (,)
- SR2 type: Either line feed (LF) or carriage return·line feed (CR·LF) can be accepted. CR and LF in ASCII code are 0D and 0A in hexadecimal, respectively.

Note: 1. Device messages are explained in further detail in Section 5.
2. The correspondence of device messages and function keys is given as Appendix 1, and a list of device messages is given as Appendix 2.

4.2 General Formats of Control Message

Control messages are used to control the MS560J operation. There are four formats, each will be explained by using instructions for the Packet II Personal Computer. (In Packet II WRITE statement, SR2 is automatically output at the end of each message.)

4.2.1 Control message format 1

This message format consists of a HR and SR2 as shown in the figure.

Program example

If the following instruction is executed, SR2 is automatically output after HR:

```
WRITE @101: "IN"
            |||
            ||└── HR of INITIAL SET
            |└─── GP-IB address of MS560J
            └──── Select code of Packet II interface
```

4.2.2 Control message format 2

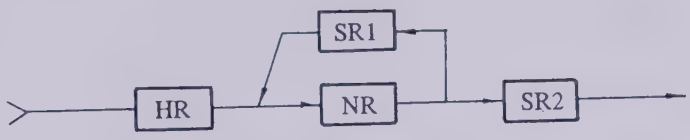
This message format consists of a HR, a NR, and SR2 as shown in the figure.

Program example

```
WRITE @101: "TR0"
            ||└── NR for MAG setting
            └─── HR for TRACE

WRITE @101 USING "C, A": "EX", E
                         ||└── NR (variable) for switching EXP
                         └─── HR for EXP
```

4.2.3 Control message format 3



This message format is used to repeat the combination of a NR and a SR1 several times between a HR and SR2 as shown in the above figure.

Program example

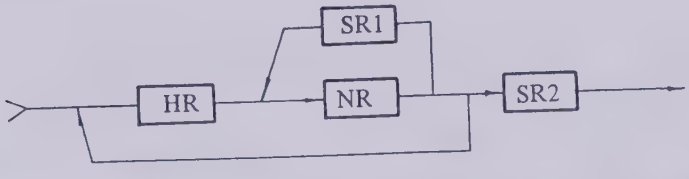
WRITE @101: "FC100, 1000"

- NR for SPAN frequency
- SR1
- NR for CENTER frequency
- HR for CENTER/SPAN

WRITE @101: "BW6, 7"

- NR for VBW
- SR1
- NR for RBW
- HR for RBW/VBW

4.2.4 Control message format 4



This message format is used to transmit two or more control messages at one time. The MS560J can receive two or more control messages at one time, except for some specific message combinations.

Program example

WRITE @101: "TR0 BW6, 7 IR3"

Note that the following message combinations are not available:

(1) TRACE and SCALE A/B or OFFSET A/B

(2) Functions which can be set to ON only by TRACE and LEVEL or SPECT

(3) REPEAT START or SINGLE START and other control messages

(4) CAL (X → S) and other control messages

(5) INITIAL SET and other control messages

4.3 General Formats of Data Request Messages

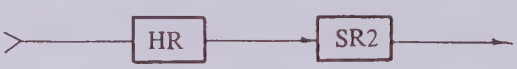
A data request message is used to read data of functions, measurement results, and measurement memory from the MS560J. A data request message header consists of a control message header added character R.

To read data from the MS560J, a data request message must be sent just before the operation.

> When the MS560J is talker, (CR)(LF) is added to the end of the data and transmitted.
> The data is the same format as a control message with HR and SR2 removed.

There are two formats:

4.3.1 Data request message format 1



This message format consists of a HR and SR2.

Program example

```
100 WRITE @101: "TRR"
110 READ @101: A
```

4.3.2 Data request message format 2

This message format consists of HR, NR, SR1, NR, and SR2.

Program example

```
100 WRITE @101: "XAR0, 251"
110 FOR I=0 TO 250
120 READ @101: A(I)
130 NEXT I
```

SECTION 5 DETAILS OF DEVICE MESSAGES

In this Section, MS560J device messages are explained in detail. For function settings at power-up, see APPENDIX 3 FRONT PANEL STATUS AT POWER-ON.

5.1 DISPLAY FUNCTION

5.1.1 TRACE

(1) Control message

TRm Sets corrrsponding TRACE function

m	TRACE
0	MAG
1	PHA
2	DLY
3	LEVEL (R)
4	LEVEL (T)
5	MAG
6	MAG/PHA
7	MAG/DLY
8	SPECT (R)
9	SPECT (T)

(2) Data request message

TRR

5.1.2 LIN/RANGE/TRIGGER LEVEL

(1) Control message

LIn, m, l Sets on/off the LIN, IF RANGE value, and TRIGGER LEVEL. The RANGE value displayed on the CRT is the sum of the IF RANGE and INPUT RANGE values.

n	LIN
0	OFF
1	ON

m	IF RANGE
0	–90 dBm
1	–80
2	–70
3	–60
4	–50
5	–40
6	–30
7	–20
8	–10
9	0

l: 0 ~ 3800 This value indicates the trigger marker position. 0 is the lowest and 3800 is the highest position on the CRT scale.

Note: When TRACE is not LEVEL or SPECT, this control message is always OFF.

(2) Data request message

LIR

5.1.3 EXP

(1) Control message

EXn Turns on/off the EXPAND LIN/DLY function.

n	EXP
0	OFF
1	ON

Note: When TRACE is not DLY, *M/D, LEVEL, or SPECT, and LIN is ON, this control message is always OFF.*

(2) Data request message

EXR

5.1.4 MARKER

(1) Control message

MKm, ℓ Switches MARKER FUNCTION and sets the MAIN MARKER point.

m	MARKER FUNCTION
0	MAIN MARKER
1	ΔMARKER
2	ZERO

The specification of m can be omitted. When m is omitted, only MARKER moving is performed.

ℓ = 0 ~ 250 Indicates the MARKER point.

Note: When m=1 or 2, that is, when the MARKER FUNCTION is ΔMARKER or ZERO, ℓ is ignored.

Program example

(a) When the MARKER point is set at 100

```
100 WRITE @101: "MK, 100"
```

(b) When ΔMARKER is set at points 50 and 100

```
100 WRITE @101: "MK, 50"
110 WRITE @101: "MK1"
120 WRITE @101: "MK, 100"
```

(c) When ZERO MARKER is set at point 200 with point 125 as the base point.

```
100 WRITE @101: "MK, 125"
110 WRITE @101: "MK2"
120 WRITE @101: "MK, 200"
```

(d) When ΔMARKER or ZERO is switched to MAIN MARKER and MARKER is set at point 100.

```
100 WRITE @101: "MK0, 100"
```

(2) Data request message

MKR

5.1.5 SUB TRACE

(1) Control message

AXn, m Sets SUB TRACE.

n	SUB TRACE
0	OFF
1	ON

m	SUB TRACE
0	A → B
1	A = B
2	A – B

Note: This message is not executed when TRACE is M/P, M/D.

(2) Data request message

AXR

5.1.6 SCALE A/B

(1) Control message

SCm1, m2 This message sets SCALE A/B. Values ml and m2 indicate SCALE A and SCALE B, respectively.
SCm1 Sets SCALE A.
SC, m2 Sets SCALE B.

m1, m2	MAG, LEVEL (R)/(T), SPECT (R)/(T)	PHA	DLY
0	0.1 dB/	1 deg/	1 (see Note)
1	0.2	2	2
2	0.5	5	5
3	1	10	10
4	2	20	20
5	3	50	50
6	4	100	100
7	5	200	200

*Note: SCALE of DLY is obtained by multiplying the value shown in the above table by one hundredth (EXP off) or one thousandth (EXP on) of **DELAY RANGE** (1 μs ~ 400 ms).*

(2) Data request message

SCR

5.1.7 OFFSET A/B

(1) Control message

OFℓ1, ℓ2 Sets OFFSET A/B. Values ℓ1 and ℓ2 indicate OFFSET A and OFFSET B, respectively.
OFℓ1 Sets OFFSET A.
OF, ℓ2 Sets OFFSET B.

ℓ1, ℓ2: +20000 ~ –20000

Note: The least significant digit of ℓ1 and ℓ2 are assumed as the least significant digit of OFFSET A/B. The least significant digit of MAG, LEVEL, and SPECT is 0.01 dB, that of PHA is 0.1 deg, and that of DLY is one thousandth of DELAY RANGE. When DLY EXP is on, however, values 1, 2 and 4 times these values are displayed by selecting DR (Delay Range) step (1, 2, 4).

(2) Data request message

OFR

5.2 MEASURE FUNCTION

5.2.1 LOG START/STOP FREQUENCY

(1) Control message

FLm1, m2 Sets frequencies. m1 and m2 indicate the LOG START and LOG STOP frequencies, respectively. (However, m1 < m2.)
FLm1 Sets the LOG START frequency.
FL, m2 Sets the LOG STOP frequency.

m1	m2	FREQUENCY
0	x	100 (Hz)
1	1	1 K
2	2	10 K
3	3	100 K
4	4	1 M
5	5	10 M
x	6	100 M
x	7	300 M

(2) Data request message

FLR

5.2.2 LIN START/STOP FREQUENCY

(1) Control message

FSℓ1, ℓ2 Sets frequencies. ℓ1 and ℓ2 indicate the START and STOP frequencies, respectively.
FSℓ1 Sets the START frequency.
FS, ℓ2 Sets the STOP frequency.

$\ell 1 \leqslant \ell 2$
ℓ1, ℓ2: 0.0 ~ 30000000.0 Hz (in 2.5 Hz steps)

(2) Data request message

FSR

5.2.3 LIN CENTER/SPAN FREQUENCY

(1) Control message

FCℓ1, ℓ2 Sets frequencies. ℓ1 and ℓ2 indicate the CENTER and SPAN frequencies, respectively.
FCℓ1 Sets the CENTER frequency.
FC, ℓ2 Sets the SPAN frequency.

$\ell 2 \leqslant 2 \cdot \ell 1$
ℓ1, ℓ2: 0.0 ~ 30000000.0 Hz (in 2.5 Hz steps)

(2) Data request message

FCR

5.2.4 FREQUENCY SETTING

(1) Control message

FPn Sets the frequency setting mode.

n	Setting mode
0	LOG START/STOP
1	START/STOP
2	CF/SPAN

(2) Data request message

FPR

5.2.5 OUTPUT (START)/STOP/STEP LEVEL

(1) Control message

LLℓ1, ℓ2, ℓ3 Sets output levels. ℓ1, ℓ2, and ℓ3 indicate the output levels of OUTPUT (START), STOP, and STEP, respectively.
LLℓ1 Sets the OUTPUT (START) level.
LL, ℓ2 Sets the STOP level.
LL, ℓ3 Sets the STEP level.

ℓ1, ℓ2, ℓ3: +10.00 ~ 110.00 (dBm or dB)

Note: When LEVEL SWEEP is OFF, ℓ1 indicates the output level, and when LEVEL SWEEP is ON, ℓ1 indicates the start level.

(2) Data request message

LLR

5.2.6 LEVEL SWEEP

(1) Control message

LWn Switches the LEVEL SWEEP function.

n	LEVEL SWEEP
0	OFF
1	ON

(2) Data request message

LWR

5.2.7 INPUT RANGE

(1) Control message

IRm Sets the INPUT RANGE value.

m	INPUT RANGE
0	–40 (dBm)
1	–30
2	–20
3	–10
4	0
5	+10
6	+20

(2) Data request message

IRR

5.2.8 DELAY RANGE

(1) Control message

DRm Sets the DELAY RANGE value.

m	DELAY RANGE
0	100 (nS)
1	200
2	400
3	1 (μS)
4	2
5	4
6	10
7	20
8	40
9	100
10	200
11	400
12	1 (ms)
13	2
14	4
15	10
16	20
17	40

Note: This message is executed only when TRACE is DLY or M/D.

(2) Data request message

DRR

5.2.9 RES/VIDEO BW

(1) Control message

BWm1, m2 Sets the BW value. m1 and m2 indicate the values of RES BW and VIDEO BW respectively.
BWm1 Sets the RES BW value.
BW, m2 Sets the VIDEO BW value.

m1	m2	BW
x	0	1 (Hz)
1	1	3
2	2	10
3	3	30
4	4	100
5	5	300
6	6	1K
7	7	3K
8	8	10K
9	9	30K

Note: This message is not executed when COUPLED TO FREQ or COUPLED TO SPAN is ON.

(2) Data request message

BWR

5.2.10 SWEEP TIME

(1) Control message

STℓ Sets the SWEEP TIME value.

ℓ: 100 ~ 90000000 mS (The first two digits are significant.)

Note: This message is not executed when COUPLED TO FREQ or COUPLED TO SPAN is ON.

(2) Data request message

STR

5.2.11 IMPEDANCE R/T

(1) Control message

IMm1, m2 Switches input/output impedances.

m1	m2	IMPEDANCE
0	0	50 Ω
1	1	OPT

(2) Data request message

IMR

5.2.12 OUTPUT A/B

(1) Control message

OPm Switches OUTPUT A/B.

m	OUTPUT
0	A
1	B

(2) Data request message

OPR

5.2.13 SIGNAL TRACK

(1) Control message

ATn Switches the SIGNAL TRACK status.

n	SIGNAL TRACK
0	OFF
1	ON

Note: The SIGNAL TRACK is always OFF when the TRACE is not LEVEL or SPECT.

(2) Data request message

ATR

5.2.14 COUPLED TO FREQ

(1) Control message

CFn, m Switches the COUPLED TO FREQ status.

n	COUPLED TO FREQ
0	OFF
1	ON

m	ST AUTO
0	x2
1	x1
2	x0.5
3	x0.2
4	x0.1

Note: If COUPLED TO FREQ is set to OFF, m is reset to 1.

(2) Data request message

CFR

5.2.15 COUPLED TO SPAN

(1) Control message

CPn Switches the COUPLED TO SPAN status.

n	COUPLED TO SPAN
0	OFF
1	ON

Note: The COUPLED TO SPAN is always OFF when the TRACE is not LEVEL or SPECT.

(2) Data request message

CPR

5.2.16 CAL X-S

(1) Control message

XSn Switches the X-S function.

n	X-S
0	OFF
1	ON

(2) Data request message

XSR

5.2.17 TRACK ADJ

(1) Control message

BTn, ℓ Switches the TRACK ADJ function and adjusts RBW tuning.

n	TRACK ADJ
0	OFF
1	ON

ℓ : 0 ~ 255 Sets the voltage for adjusting RBW tuning.
For details, refer to "TRACKING ADJUST" in paragraph 2.8-(29) in the MS560J Network/Spectrum Analyzer Operation Manual.

(2) Data request message

BTR

5.2.18 UNCAL

(1) Control Message

None.

(2) Data request message

This function indicates the UNCAL lamp status.

UCR Data output from the MS560J is 0 or 1.

0: NO UNCAL
1: UNCAL

5.2.19 OVER LOAD

(1) Control message

None.

(2) Data request message

This functions indicate the status of the OVER LOAD lamp.

OVR Data output from the MS560J is 0, 1, 2 or 3.

0: NO OVER LOAD
1: R-side OVER LOAD
2: T-side OVER LOAD
3: R- and T-side OVER LOAD

Note: Execute OVER after activating SWEEP START.

5.3 CONTROL FUNCTION

5.3.1 SWEEP AUTO/MARKER

(1) Control message

AMn Switches AUTO/MARKER.

n	AUTO/MARKER
0	AUTO
1	MARKER

(2) Data request message

AMR

5.3.2 SWEEP STOP/RESET

(1) Control message

MEm Stops or resets the sweep.

m	STOP/RESET
0	STOP
1	RESET

(2) Data request message

MER Outputs the current sweep status with 0 or 1.

0: Sweep ended
1: Sweeping

Note: The end of sweeping can also be detected by a serial polling interrupt. For details, refer to "Sweep termination" in paragraph 6.3.1.

5.3.3 SWEEP REPEAT/SINGLE START

(1) Control message

MSm Activates sweep REPEAT START or SINGLE START.

m	SWEEP START
0	REPEAT
1	SINGLE

(2) Data request message

None.

5.3.4 PTA

(1) Control message

PTn Switches the PTA function.

n	PTA
0	OFF
1	ON

Note: When the PTA option is not incorporated in the MS560J, PTA is always OFF.

(2) Data request message

PTR

5.3.5 CAL INT

(1) Control message

IT Executes INTERNAL CAL once. If a sweep operation is under way, execution of this message is delayed until the sweep operation is terminated.

5.3.6 CAL X→S

(1) Control message

CS Executes CAL X→S.

(2) Data request message

None.

Note: Termination of CAL X→S execution can be obtained by MER (data request message for sweep termination).

5.3.7 SAVE

(1) Control message

SV m1, m2 Saves all MS560J functions in internal memory or PBMI.

	m1	m2
REG	0	0～2
MEM	1	0～5

REG: Internal memory
MEM: Plug-in bubble memory (PBM)

Note: Waits for five seconds or more when transmitting another device message after transmitting control message SV1, m2.

(2) Data request message

None.

5.3.8 RECALL

(1) Control message 1

RCm1, m2 Recalls all MS560J functions from internal memory or the **PBMI** and sets them to MS560J.

	m1	m2
REG	0	0 ~ 2
MEM	1	0 ~ 5

REG: Internal memory
MEM: Plug-in bubble memory (PBM)

*Note: Waits for five seconds or more when transmitting another device message after transmitting control message **RCI, m2.***

(2) Control message 2

The following control functions exclusive of recalling the function memory.

RC0,3 : MKR → OFS
RC0,4 : ΔMKR → SPAN
RC0,5 : MKR → CF
RC0,6 : MKR → PEAK
RC0,9 : INIT

(3) Data request message

None.

5.3.9 INITIAL SET

(1) Control message

IN Sets all MS560J functions to the initial power-on. See APPENDIX 3 FRONT PANEL STATUS AT POWER ON.

(2) Data request message

None.

5.3.10 BREAK POINT

The MS560J ordinarly measures 251 points, and higher measurement rates are available by decreasing the number of measurement points by setting a break point. The measurement area is from point 0 to the specified point. For details, see "Program for Rapid Measurement by Decreasing Measurement Points" in paragraph 8.4.

(1) Control message

BPℓ Sets a break point.

ℓ: 1 ~ 251 (If ℓ is set from 252 to 255, ordinary measurement is done.)

(2) Data request message

BPR

5.4 ADV FUNCTION

5.4.1 INTEGRATING

(1) Control message

IGn Switches the INTEGRATING function.

n	INTEGRATING
0	OFF
1	ON

(2) Data request message

IGR

5.4.2 MAX. HOLD

(1) Control message

MHn Switches the MAX. HOLD function.

n	MAX. HOLD
0	OFF
1	ON

Note: The MAX. HOLD function is always OFF when the TRACE is not LEVEL or SPECT.

(2) Data request message

MHR

5.4.3 FREQUENCY COUNT

(1) Control message

FOn Switches the FREQUENCY COUNT function.

n	FREQUENCY COUNT
0	OFF
1	ON

Note: The FREQUENCY COUNT function is always OFF when the TRACE is not LEVEL or SPECT.

(2) Data request message

FOR

(3) Data request message for measurement results of FREQUENCY COUNT and the marker readout frequency.

MFR

Note: Since FREQUENCY COUNT operation is executed after sweep operation is terminated, wait for about 1.5 second after sweep termination before reading the data.

5.4.4 SWEEP MARKER

(1) Control message

SMn Switches the SWEEP MARKER function.

n	SWEEP MARKER
0	OFF
1	ON

(2) Data request message

SMR

5.4.5 BUZZER

(1) Control message

BZn Switches the BUZZER function.

n	BUZZER
0	OFF
1	ON

(2) Data request message

BZR

5.4.6 AUTO CAL. TIMER

(1) Control message

CTℓ Switches the AUTO CAL. TIMER function and sets the timer.

ℓ: 0 ~ 99 minute (If ℓ is 0, the AUTO CAL. TIMER is set to OFF.)

Note: Although TIMER = 0 when the power is turned ON, INTERNAL CAL. is executed once about 15 minutes after power on.

(2) Data request message

CTR

5.4.7 TITLE

(1) Control message

TT, abcdef, Displays title data of up to 15 characters delimited by two commas (, ,). In this example, "abcdef" is the title.

TT, , Clears title data.

(2) Data request message

TTR

5.4.8 SRQ

(1) Control message

SQn Switches the SRQ function.

n	SRQ
0	OFF
1	ON

Note: SRQ is OFF at power on. For details on SRQ, refer to SECTION 6 INTERRUPT, and "SRQ command" in paragraph 7.1.2.

(2) Data request message

SQR

5.4.9 DELIMIT

(1) Control message

DMn Switches the DELIMIT function.

n	DELIMIT
0	OFF
1	ON

Note: DELIMIT is OFF at power on. For details on DELIMIT, refer to "DLI command" in paragraph 7.1.3.

(2) Data request message

DMR

5.4.10 SEND

(1) Control message

None.

(2) Data request message

SDR One character of SEND status is output from the MS420[ ].

Note: For details on SEND status, refer to "SEND" in paragraph 6.3.2 and "SND command" in paragraph 7.1.4.

5.5 Measurement Memory

The MS560J has frequency memory, level memory, measurement and S memories for channel A/B, each with a capacity of 251 points. For details, refer to "Measurement memory system" in paragraph 5.5.8.

5.5.1 Frequency memory

If a measurement frequency range is input to the MS420[ ] by LOG START/STOP, START/STOP, or CENTER/SPAN, each frequency is stored in frequency memory, with a capacity of 251 points. The frequency at a specific measurement point can be updated or read out of the frequency memory.

(1) Control message

FQℓ Specifies the address of the frequency memory. ℓ is an integer from 0 to 250 indicating the measurement point.

• Program example

This program sets the frequencies of measurement points 150 to 159 in 1 kHz steps starting from 5 kHz.

```
10 WRITE @101:"FQ150"  — Specifies the address of frequency memory.
20 LET FREQUENCY=5000  — Specifies frequency 5 kHz.
30 FOR I=150 TO 159    — Specifies repetition of setting frequency range from point 150
                         to 159.
40 WRITE @101 USING "A":FREQUENCY — Specifies frequency setting.
```

Note: 1. FREQUENCY: 0.0 ~ 300000000.0 Hz
2. Increments the frequency memory address.
3. USING "A" is an instruction to transfer values in a format with an automatic number of significant digits.

```
50 LET FREQUENCY=FREQUENCY+1000 — Specifies 1 kHz increment.
60 NEXT I
```

Note: 1. If a new frequency is set by LOG START/STOP, START/STOP, or CENTER/SPAN after execution of this control message, the previous frequency stored in the frequency memory is replaced by the new value.
2. If this control message is executed after the frequency is set by LOG START/STOP, START/STOP, or CENTER/SPAN, start execution after one or more seconds has elapsed.

(2) Data request message

FQR ℓ1, ℓ2 The MS560J transmits the frequency data of ℓ2 points starting from point ℓ1.
ℓ2 = 251 – ℓ1

• Program example

```
10 DIM F(251)
20 WRITE @101:"FQR0,251" —Requests the frequency data from point 0 to 250.
30 FOR I=0 TO 250
40 READ @101:F(I)  ——— Reads the frequency data of 251 points from the MS560J.
50 NEXT I
```

5.5.2 Output level memory

The MS560J has an output level memory with a capacity of 251 points. If an output level is input by START, STOP, or STEP, it is stored in this output level memory. The output level at a specific measurement point can be updated or read out of output level memory.

(1) Control message

LVℓ Specifies the address of level memory. ℓ is an integer from 0 to 250, and indicates the measurement point.

• Program example

Setting the output level of measurement point 10 to 13 in 0.02 dB steps starting from −20 dBm.

```
10 WRITE @101:"LV10"  ————————  Specifies the level memory address.
20 LET LEVEL=-20      ————————  Specifies level −20 dBm.
30 FOR I=10 TO 13     ————————  Specifies repetition of output level setting from
                                point 10 to 13.
40 WRITE @101 USING "A":LEVEL —  Specifies output level setting.
```

Note: 1. LEVEL: −110.00 ~ +10.00 dBm
2. Increments the output level memory address.

```
50 LET LEVEL=LEVEL+.02
60 NEXT I
70 END
```

Note: 1. If a new output level is set by START, STOP, or STEP after execution of this control message, the previous output level stored in the output level memory is replaced by the new value.
2. If this control message is to be executed after the output level is set by START, STOP, or STEP, it must be started after at least one second has elapsed.

(2) Data request message

LVRℓ1, ℓ2 The MS560J transmits 12 points of level starting from point ℓ1.

ℓ2 = 251 − ℓ1

• Program example

```
10 DIM L(251)
20 WRITE @101:"LVR0,251"  — Requests output level data of point 0 to 250.
30 FOR I=0 TO 250
40 READ @101:L(I)  ————————  Reads output level data of 251 points from MS560J.
50 NEXT I
60 END
```

5.5.3 Measurement memory for channel A

Measurement results of the following TRACE functions are stored in measurement memory for channel A:

(a) All **TRACE** during 1 channel measurement

(b) **MAG** during 2 channel measurement

Data in this memory can be updated by personal computer. When SWEEP is started, however, the measurement results replace the data.

(1) Control message

XAℓ Sets the measurement memory address for channel A. ℓ is an integer from 0 to 250 indicating the measurement point.

Note: Data transmitted after XAℓ is integer type, and least significant digit is the minimum measurement resolution.

(2) Data request message

XARℓ1, ℓ2 The MS560J transmits ℓ2 points of measurement results of channel A starting from point ℓ1.

Note: Data transmitted by MS560J is integer type, and least significant digit is the minimum measurement resolution.

• Program example

SWEEP SINGLE START is specified for the MS560J, and when SWEEP is terminated, all MAG measurement results are read, converted to MAG resolution, and stored into variable MAG (I).

```
10 DIM MAG(251) ————————— Register the same number of variable areas as the number
                           of measurement points.
20 WRITE @101:"TR0" ————— Set TRACE FUNCTION to MAG
30 WRITE @101:"MS1" ————— SINGLE START
40 WAIT DELAY .3
50 WRITE @101:"MER" ————— Request SWEEP STATUS
60 READ @101:ME ————————— Read SWEEP STATUS
70 IF ME=1 THEN 40 ————— Wait for until SWEEP terminates
80 WRITE @101:"XAR0,251" — Request measurement results.
90 FOR I=0 TO 250
100 READ @101:MAG(I) ———— Read measurement results
110 LET MAG(I)=MAG(I)*.01 — Convert to MAG measurement resolution
120 NEXT I
130 END
```

5.5.4 Measurement memory for channel B

Measurement results of the following TRACE functions are stored in the channel B measurement memory:

(a) P(PHA) or D(DLY) during 2 channel measurement **(M/P or M/D)**

(b) **SUB TRACE**

Data in this memory can also be updated by personal computer. When SWEEP is started when **SUB TRACE** is **B=A**, however, measurement results replace the data.

(1) Control message

XBℓ Sets the address of the measurement memory for channel B. ℓ is an integer from 0 to 250 indicating the measurement point.

Note: Same as 5.5.3 (1).

(2) Data request message

XBRℓ1, ℓ2 The MS560J transmits ℓ2 points of measurement results of channel B starting from point ℓ1.

Note: Same as 5.5.3 (2).

- Program example

This program reads measurement results of MAG and PHA from point 100 to 200, converts them to MAG and PHA resolutions, and stores the results into variable MAG(I) and PHA(I).

```
10 DIM MAG(251),PHA(251)  ——  Register variable area
20 WRITE @101:"XAR100,101"  —  Request MAG measurement results
30 FOR I=100 TO 200
40 READ @101:MAG(I)  ————————  Read MAG measurement results
50 LET MAG(I)=MAG(I)*.01  ——  Convert to MAG measurement resolution
60 NEXT I
70 WRITE @101:"XBR100,101"  —  Request PHA measurement results
80 FOR I=100 TO 200
90 READ @101:PHA(I)  ————————  Read PHA measurement results
100 LET PHA(I)=PHA(I)*.1  ———  Convert to PHA measurement resolution
110 NEXT I
120 END
```

5.5.5 S memory for channel A

Measurement results of channel A are stored in S memory by **CAL X→S**. Data in S memory can also be updated by personal computer source. When **CAL X→S** is executed, however, channel A measurement results replace the data.

(1) Control message

SAℓ Sets the address of S memory for channel A. ℓ is an integer from 0 to 250 indicating the measurement point.

Note: Same as 5.5.3 (1).

(2) Data request message

SARℓ1, ℓ2 The MS560J transmits. ℓ2 points of data stored in the S memory for channel A starting from point ℓ1.

Note: Same as 5.5.3 (2).

5.5.6 S memory for channel B

Measurement results of channel B are stored in S memory for channel B. Datas in this memory can also be updated by personal computer. When **CAL X→S** is executed, however, channel B measurement results replace the data.

(1) Control message

SBℓ Sets the address of S memory for channel B. ℓ is an integer from 0 to 250 indicating the measurement point.

Note: Same as 5.5.3 (1).

(2) Data request message

SBRℓ1, ℓ2 The MS560J transmits ℓ2 points of data stored in the S memory for channel B starting from point ℓ1.

Note: Same as 5.5.3 (2).

5.5.7 Reading measurement results

The data read methods explained in paragraph 5.5.3 and 5.5.4 read integer data on one channel.
Another data read method is presented in this section.

(1) Control message

None.

(2) Data request message

Transmits data stored in measurement memory in the measurement format, that is, in the digital display format (measurement results display at marker point).

MMRℓ1, ℓ2 The MS560J transmits ℓ2 points of measurement data starting from point ℓ1 in the measurement format.

MMR Transmits data at the marker point.

Measurement value at the marker point of channel A or channel A/B. For ZERO or ΔMARKER, however, the measurement value obtained at ZERO or MARKER is assumed.

(a) Measurement by one channel

Measurement format	Reading format
−10.12 dBm	−10.12 CRLF
0.10 dB	0.1 CRLF
150.3 deg	150.3 CRLF
20.0 μS	20 CRLF

(b) Measurement by two channels

Measurement data of channels A and B is transmitted alternately in the format as shown in the table in 5.5.7 (a).

- Program example 1

This program reads the measurement results when TRACE is M/P and **DELIMIT** is **OFF**.

```
10 DIM MAG(250),PHA(250) ———————— Register variable area
20 WRITE @101:"DM0" ———————————— DELIMIT OFF
30 WRITE @101:"MMR0,251" ———————— Request measurement data
40 FOR I=0 TO 250
50 READ @101:MAG(I)¥READ @101:PHA(I) — Read measurement data
60 NEXT I
70 END
```

Note: The delimiter for MAG and PHA data is (CR) (LF).

- Program example 2

This program reads the measurement results when TRACE is M/P and **DELIMIT** is **ON**.

```
10 DIM MAG(250),PHA(250) —— Register variable areas
20 SEPARATER IS ";" ————— Set delimiter (;)
30 WRITE @101:"DM1" ————— Set DELIMIT to ON
40 WRITE @101:"MMR0,251" —— Request measurement data
50 FOR I=0 TO 250
60 READ @101:MAG(I),PHA(I) — Read measurement data
70 NEXT I
80 END
```

Note 1: The delimiter for MAG and PHA data is a semicolon (;).

−34.56 (MAG) ; 156.7 (PHA) (CR)(LF)

Note 2: Data length is fixed.
Examples at MAG, LEVEL, or SPECT.

−100, 12 (CR)(LF)
−Δ10, 12 (CR)(LF)
ΔΔΔ1, 23 (CR)(LF)

Δ : Space

(c) Reading marker data

- Program example 1

This program reads marker data measured by MAG.

```
10 WRITE @101:"MMR" — Request marker data
20 READ @101:MAG —— Read the value measured at the marker point by MAG.
30 END
```

- Program example 2

In this example, TRACE is set to LEVEL(T) and the frequency and level of the 10 MHz input signal are measured and stored in the FREQUENCY and LEVEL variable areas.

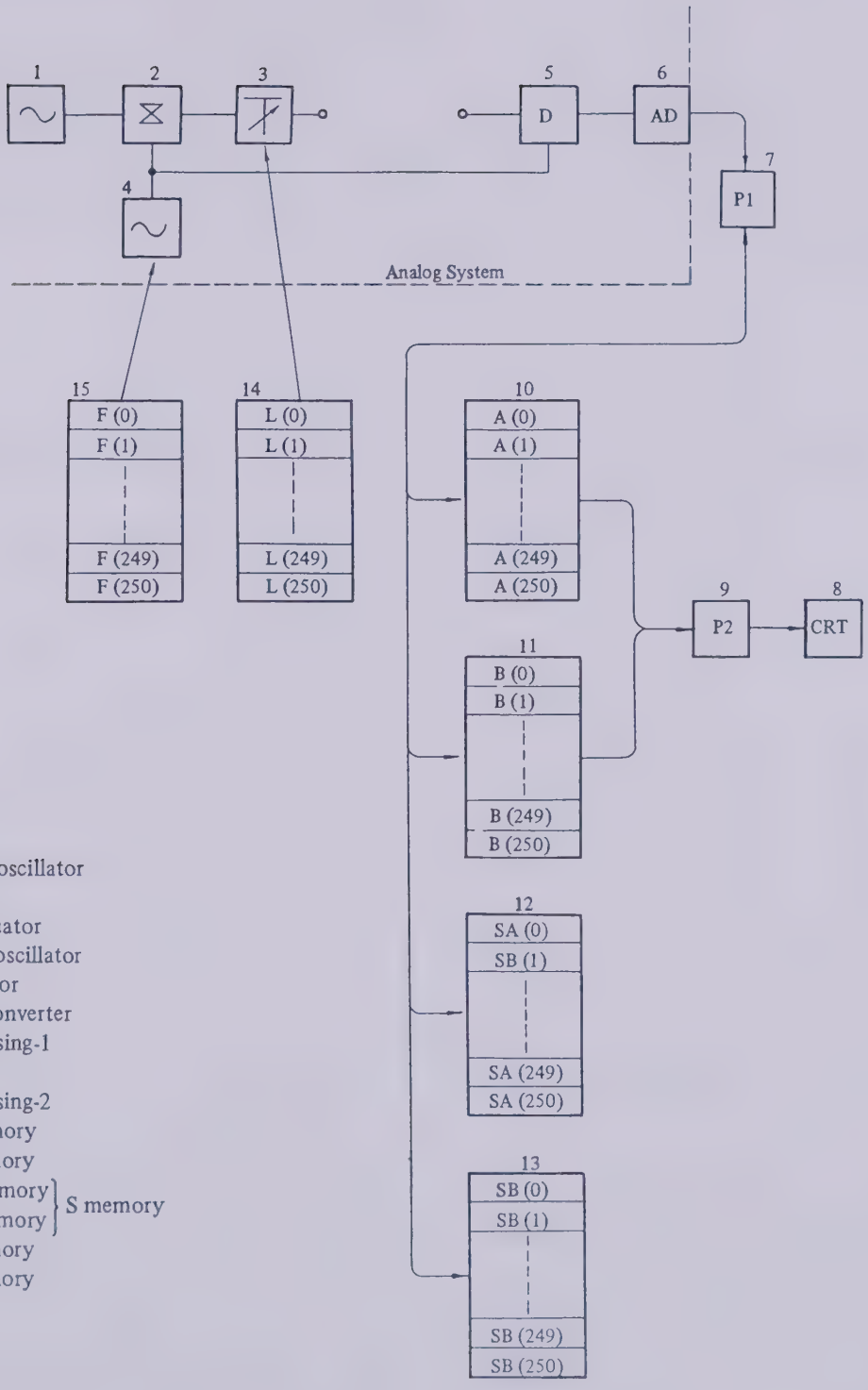
```
10 DIM LEVEL(250) ———————— Register a work area
20 WRITE @101:"TR4" ———————— Set TRACE to LEVEL(T)
30 WRITE @101:"FC10000000,100000FQ1" — Set CENTER=10MHz, SPAN=100kHz,
                                       and FREQUENCY COUNT to ON
40 WRITE @101:"MS1" ———————— SWEEP START
50 WAIT DELAY .3
60 WRITE @101:"MER"
70 READ @101:ME ———————— Wait for SWEEP termination
80 IF ME=1 THEN 60
90 LET MAX=-200
100 WRITE @101:"MMR0,251" ———————— Request level measurement data
110 FOR I=0 TO 250
120 READ @101:LEVEL(I) ———————— Read measurement data
130 IF MAX>LEVEL(I) THEN 150 ———————— Obtain input level
140 LET MAX=LEVEL(I)
150 NEXT I
160 WRITE @101:"MFR" ———————— Request the FREQUENCY COUNT
                                results
170 READ @101:FREQUENCY ———————— Read the input signal frequency
180 END
```

5.5.8 MEMORY SYSTEM

The MS560J performs measurements on the basis of arrayed configuration memory. Descriptions are loaded in this memory system as described below.

Figure 5-1 shows how this system is connected to an analog system. The flow of measurements based on this figure is shown in Figure 5-2. The X values (measured values at each point) in the figure are stored in memories A, B, SA, and SB through the flow shown in Table 5-1. P2 processing as shown in the table is the adjustment of SCALE and OFFSET.

Figure 5-3 shows the operating functions for these memories. This figure shows how to control an element of each memory by peripheral units. For example, if the GP-IB and PTA option are used, it means that all memories can be operated freely.



Notes:

1. Fixed oscillator
2. Mixer
3. Attenuator
4. Local oscillator
5. Detector
6. A/D converter
7. Processing-1
8. CRT
9. Processing-2
10. A memory
11. B memory
12. SA memory } S memory
13. SB memory }
14. L memory
15. F memory

Fig. 5-1 Connection Between Memory System and Analog System

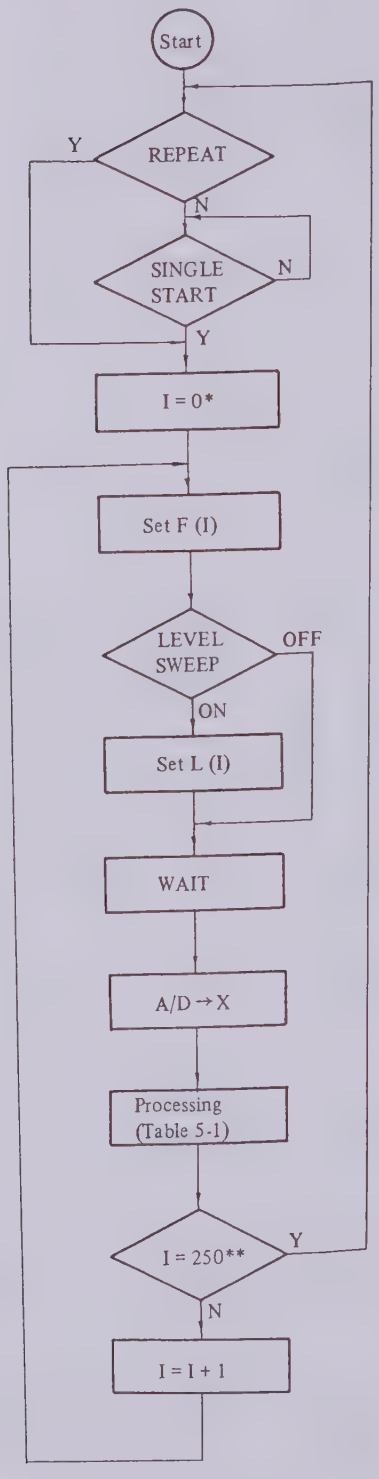


Fig. 5-2 Measurement Flowchart

Note

1. For marker sweep operation, * and ** become the value at the marker point.
2. For Δmarker sweep operation, * and ** are the start and stop points, respectively.

Table 5-1 Measurement Data Processing

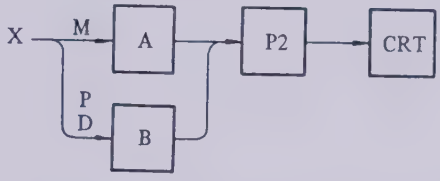
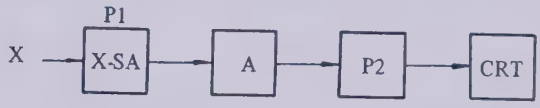
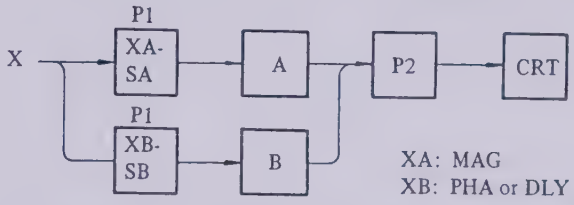
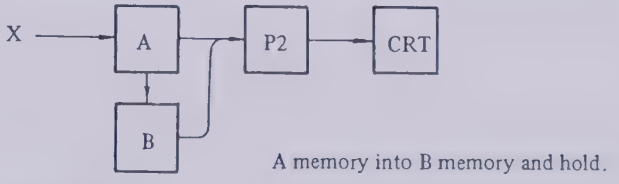
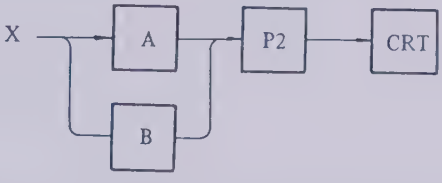
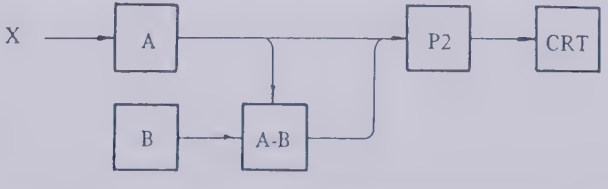
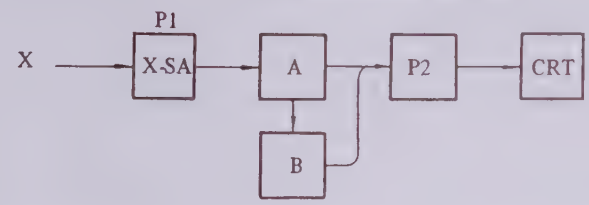
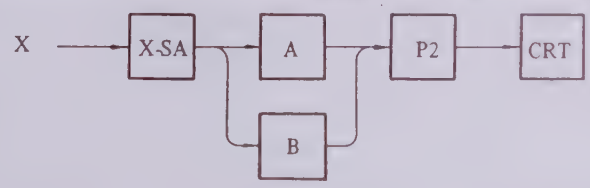
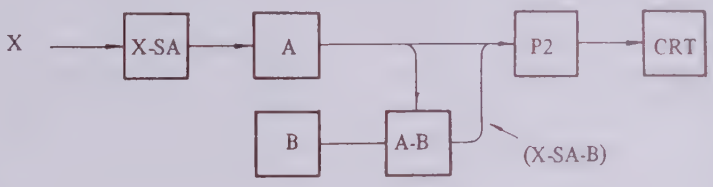
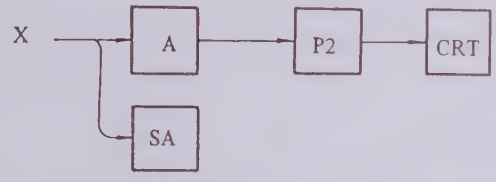
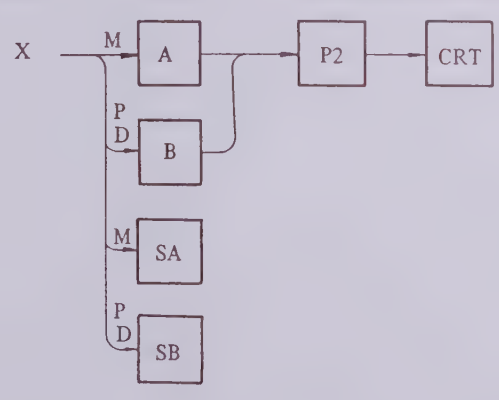
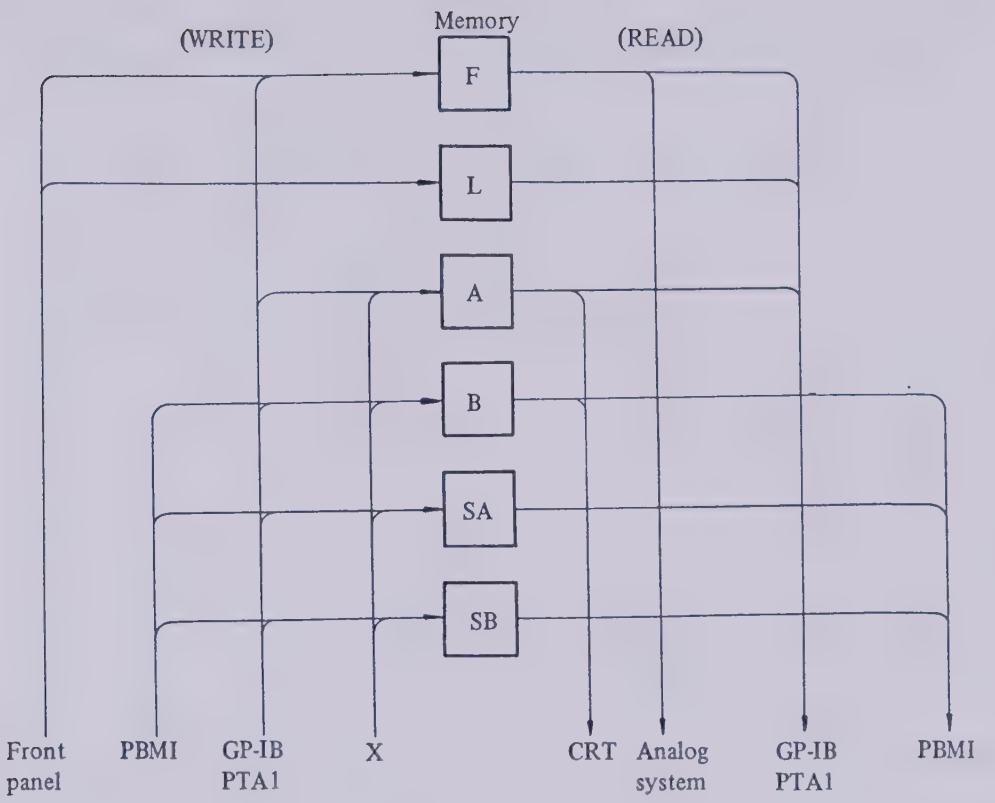
Functions			Data flow
MAG, PHS, DLY, LEVEL, SPECT X-S; OFF SUB TRACE: OFF			
M/P, M/D X-S; OFF SUB TRACE: OFF			
MAG, PHS, DLY, LEVEL, SPECT X-S; ON SUB TRACE: OFF			
M/P, M/D X-S; ON SUB TRACE: OFF			
MAG PHS DLY LEVEL SPECT SUB TRACE : ON	X-S: OFF	A→B	
		B = A	
		B = A – B	

Table 5-1 Measurement Data Processing (Cont'd)

Functions			Data flow
MAG PHS DLY LEVEL SPECT SUB TRACE: ON	X-S: ON	A → B	
		B = A	
		B = A – B	
MAG, PHS, DLY, LEVEL, SPECT One sweep after pressing the [X → S] key.			
M/P, M/D One sweep after pressing the [X → S] key.			



Variable name

	GP-IB	PTA
F	FQ, FQR, MMR	F
L	LV, LVR, MMR	L
A	XA, XAR	XA
B	XB, XBR	XB
SA	SA, SAR	XSA
SB	SB, SBR	XSB

Fig. 5-3 Memory System Control

5.6 Device Messages on SCREEN Coordinates

The SCREEN can be controlled as a terminal by a personal computer with three types of device messages; display delete, character display, and graphic display.

5.6.1 Display delete message

Display delete messages are used to clear or restore the display in measurement mode (when power is on).

CRm

m	Functions
0	Clears the SCREEN
1	Restores display line 1
2	Restores display line 2
3	Restores display line 3
4	Restores display line 4
5	Restores display line 5
6	Restores display line 6
7	Restores the measurement graph and sweep marker
8	Restores the scale
9	Performs all functions for m=0 to 8 above

Note: Refer to paragraph 5.6.4 for details.

5.6.2 Character display message

Displays characters at the specified screen position, in various modes.

CCm, X, Y, abcd,

m	SCREEN mode
0	Characters are displayed high intensity in normal mode (not reversed)
1	Characters are displayed high intensity in reverse mode
2	Characters are displayed low intensity in normal mode (not reversed)
3	Characters are displayed low intensity in reverse mode

X: Integer (0 to 254) indicating a position on the X-axis of the SCREEN.
Y: Integer (0 to 216) indicating a position on the Y-axis of the SCREEN.
abcd: Characters to be displayed (up to 42 characters)

Note: The characters are actually displayed at positions X+1 and Y+1. For details, refer to SCREEN coordinate" in paragraph 5.6.4.

5.6.3 Graphic display message

A line can be drawn from a specified start point to an end point by linear interpolation.

CGm, X1, Y1, X2, Y2

m	SCREEN mode
0	A line is drawn on a high intensity screen
1	A line is drawn on a low intensity screen

X1: Integer (0 to 254) indicating a position on the X-axis
Y1: Integer (0 to 216) indicating a position on the Y-axis
X2: Integer (0 to 254) indicating the position on the X-axis
Y2: Integer (0 to 216) indicating the position on the Y-axis

Note: For details on the SCREEN, refer to "SCREEN coordinate" in paragraph 5.6.4.

5.6.4 SCREEN coordinate

The Fig. 5-4 shows a SCREEN coordinate of MS560J.

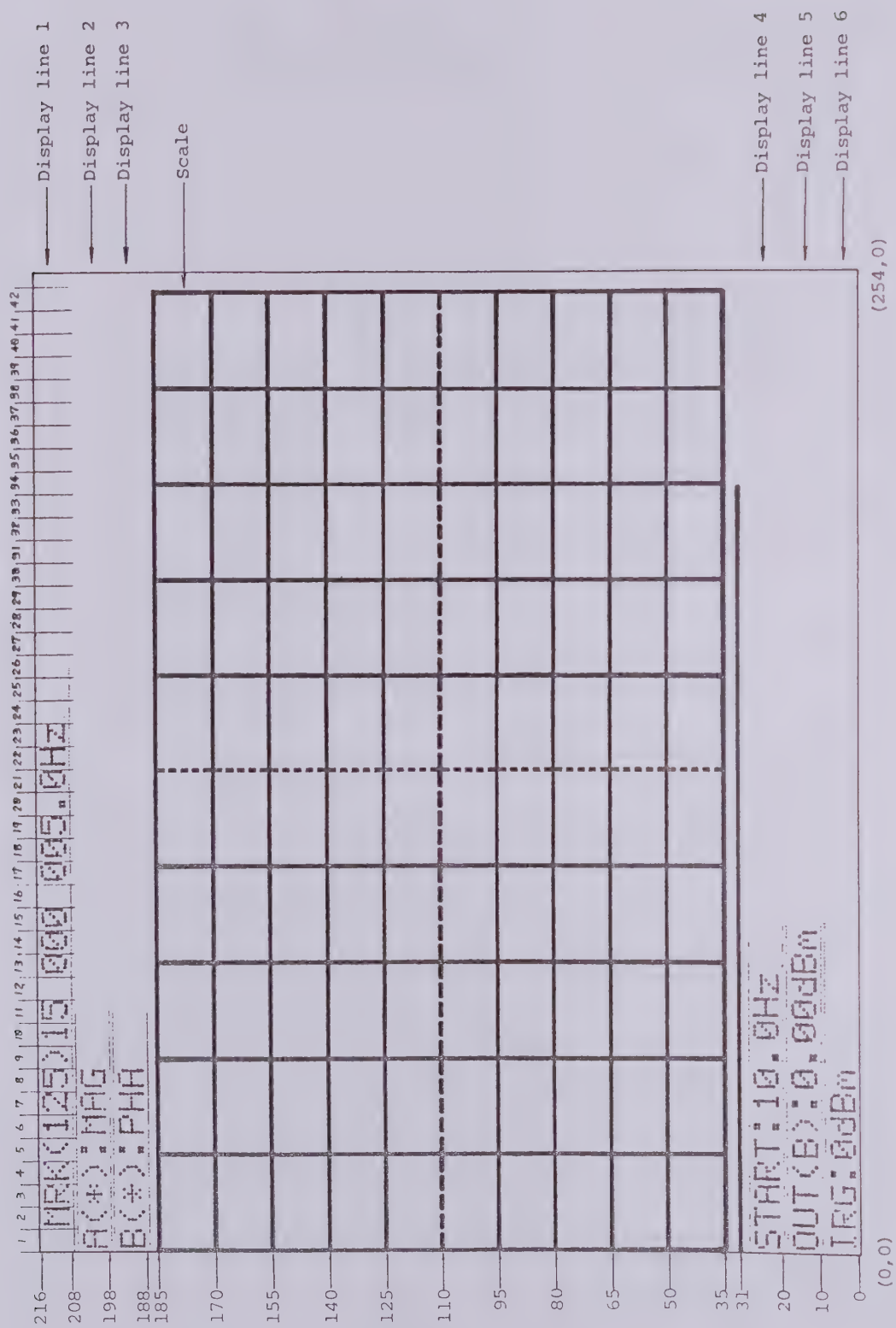


Fig. 5-4 SCREEN Coordinate

5.6.5 Program example for SCREEN control

In this example, the lines for the object to be measured are drawn on the low intensity screen, display line 6 is deleted, **MS560J NET**, **ANALYZER** is displayed on the left half of the line, and **Anritsu** is displayed on the right half in reverse mode.

```
10 WRITE @101:"CR0"                                  ← Clear the screen
20 FOR M=0 TO 5
30 WRITE @101 USING "C,A":"CR",M                     ← Restore display lines 1 to 5
40 NEXT M
50 WRITE @101:"CR7"                                  ← Restore the measurement graph
60 WRITE @101:"CR8"                                  ← Restore the scale
70 WRITE @101:"CC0,0,0,MS560J NET.ANALYZER,"         ← Display MS560J NET. ANALYZER on the left half of display line 6
80 WRITE @101:"CC1,125,0,Anritsu,"                   ← Display Anritsu on the right half of the display line, in reverse mode
90 WRITE @101:"CG1,0,70,70,70"                       ┐
100 WRITE @101:"CG1,70,70,70,160"                    ├ Draw the upper limit line
110 WRITE @101:"CG1,70,160,180,160"                  ┘
120 WRITE @101:"CG1,180,160,250,70"                  ┐
130 WRITE @101:"CG1,90,35,90,130"                    ├ Draw the lower limit line
140 WRITE @101:"CG1,90,130,160,130"                  ┘
150 WRITE @101:"CG1,160,130,160,35"
160 END
```

Note: The USING "C, A" instruction transfers characters and values with the automatic number of significant digits format.

SECTION 6 INTERRUPT

The GP-IB interface enables the talker or listener to interrupt the controller. This interrupt is activated when the talker or listener issues an **SRQ** signal. Then, the controller determines which talker or listener is the source of the interrupt. This procedure is referred to as polling.

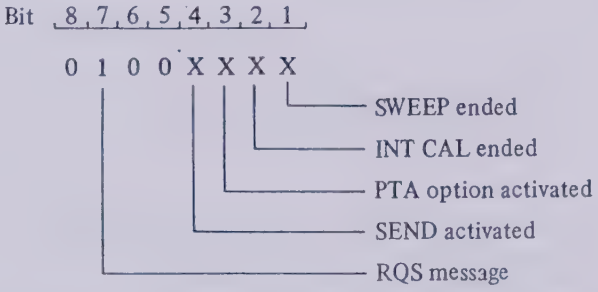
There are two types of pollings serial and parallel. The MS560J uses the serial polling function.

6.1 Serial Polling

Serial polling is a procedure to determine from which talker or listener the SRQ signal was issued. The talker or listener which issued the SRQ signal sets bit 7 (RQS message) in its status byte. Other bits indicate the status under which the SRQ signal was issued. The MS560J gets this status byte from each talker and listener and determines which talker or listener issued the SRQ signal.

6.2 Status Byte

The configuration of the status byte is as follows.



Note: The interrupt is not generated when the SRQ of the ADV function is not ON, except for SEND activation. This SRQ is OFF when power is turned on. If serial polling is done when SRQ is OFF, the RQS message bit of the status byte is output 0.

6.3 Example

6.3.1 SWEEP ended

SRQ is generated when the sweep operation ends, that is, when the SWEEP MARKER disappears. If the sweep operation is terminated by SWEEP STOP/RESET, however, the SRQ is not generated.

When the SRQ of the **ADV** function is OFF, the SRQ for sweep termination is not generated.

- Program example

In this example, MAG measurement results are read when the SRQ for SWEEP termination is generated.

```
10 COM MAG(250)                    ——— Register a variable area
20 WRITE @101:"SQ1"                ——— Set SRQ to ON
30 PROCESS EVENT GPIB"@01,02"      ——— Assert the SRQ event
40 START GPIBSRQ                   ——— Process GPIBSRQ when SRQ is generated
50 CONNECT EVENT GPIB              ——— Set a status under which an SRQ interrupt is enabled
 :
900 END
1000 PARACT GPIBSRQ URGENCY 30

1010 COM MAG(250)
1020 WAIT EVENT GPIB               ——— Read the MS560J status byte and store it in A
1030 STATUS @101:A                 ——— IF A=65 (SWEEP ended), perform operation of program
                                       number 2000 and later
1040 IF A=65 THEN 2000
 :
1100 GO TO 1020
2000 WRITE @101 "MMR0,251"         ——— Request measurement results
2010 FOR I=0 TO 250
2020 READ @101:MAG(I)              ——— Read measurement results
2030 NEXT I
2040 GO TO 1020
2050 END PARACT
```

6.3.2 SEND

The front panel keys of the MS560J can be used as a terminal for a personal computer.

With the **ADV** function, the MS560J can exchange the data to the personal computer by generating a SRQ for SEND function. For details, refer to "SND command" in paragraph 7.1.4.

6.3.3 PTA

Refer to the PTA1 Option Operation Manual.

SECTION 7 ADV FUNCTION OF GP-IB

GP-IB commands, DATA OUT, WRITE, and READ commands are available as GP-IB control functions for the **ADV** function of the MS560J Network/Spectrum Analyzer.

7.1 GP-IB Commands

There are four GP-IB commands: **ADR, DLI, SRQ,** and **SND.**

A GP-IB command is set by calling ADV line 10.

Press [BEGIN] [/] [1] [0] [EOL] in this order. The following appears on display line 6.

```
10 GP-IB COMMAND
```

7.1.1 ADR command

With the GP-IB COMMAND of the **ADV** function, the MS560J can confirm and modify GP-IB addresses. For details, refer to "Modifying GP-IB Addresses with Front Panel Keys" in paragraph 3.3.

7.1.2 SRQ command

With this command, the MS560J can switch the function for generating interrupt.

(1) Confirming SRQ

Press [S] [R] [Q] [?] [EOL] in this order. The following is displayed at the bottom of the screen, from which the SRQ status can be confirmed.

```
        GP-IB SRQ OFF
10 GP-IB COMMAND      SRQ?
```

(2) Switching SRQ

Press [S] [R] [Q] [1] (or [0]) [EOL] in this order. The following appears at the bottom of the screen, and the SRQ can be switched.

```
        GP-IB SRQ ON
10 GP-IB COMMAND      SRQ1
```

or

```
        GP-IB SRQ OFF
10 GP-IB COMMAND      SRQ0
```

Note: An UNDEFINED ERROR appears when the MS560J is a controller. This is OFF at power-up.

7.1.3 DLI command

The MS560J uses delimiters to separate output data. For details, refer to "Reading measurement results" in paragraph 5.5.7 and "DATA OUT" in paragraph 7.2.

(1) Confirming DLI

Press [D] [L] [I] [?] [EOL] in this order. The following appears at the bottom of the screen, and the DLI status can be confirmed.

```
          GP-IB DELIMIT OFF
10 GP-IB COMMAND        DLI?
```

(2) Switching DLI

Press [D] [L] [I] [1] (or [0]) [EOL] in this order. The following is displayed at the bottom of the screen, and the DLI can be switched.

```
          GP-IB DELIMIT ON
10 GP-IB COMMAND        DLI1
```

Note: This is OFF at power-on.

7.1.4 SND command

The front panel keys of the MS560J can be used as a terminal for a personal computer. The SRQ is generated by the **SND** command, an interrupt is generated for the personal computer, and keyed-in data is transmitted in ASCII code.

Press [S] [N] [D] [□] [EOL] in this order. The following appears on the bottom of the screen and SRQ is generated. (□ indicates a front panel key of the MS560J).

```
10 GP-IB COMMAND        SND□      Data read by the SDR (data request command)
```

Upon receiving the SRQ, the personal computer performs serial polling, confirms the status byte of the SND command, and reads the keyed-in data from the MS560J with the data request command (SDR).

Note: The SRQ by the SND command can be generated although the SRQ explained in "SRQ command" in paragraph 7.1.2 is OFF.

7.2 DATA OUT (Printing out Measurement Results)

With the **DATA OUT** of the **ADV** function, the MS560J can output measurement results to a printer on the GP-IB.

12 DATA OUT #1, 200, 5 ; EOL

- GP-IB address of the printer
- Measurement point from which output is to start
- Number of measurement points to be output
- Immediate execution command (a colon (:) can also be used)

- If m1 and m2 are omitted, measurement results at the marker point are output.
- If the immediate execution command (; or :) is omitted, measurement results are output whenever a sweep operation is terminated.

(1) The following is output when **DLI** is **ON**.

```
200  21409000.00Hz  -58.95dB    -7.6ms
201  21409120.00Hz  -60.58dB    -1.6ms
202  21409240.00Hz  -61.38dB    17.6ms
203  21409360.00Hz  -63.29dB     2.4ms
204  21409480.00Hz  -64.89dB    -0.4ms
```

(2) The following is output when **DLI** is **OFF**.

```
200
21409000.00Hz
-58.95dB
-7.6ms
201
21409120.00Hz
-60.58dB
-1.6ms
202
21409240.00Hz
-61.38dB
17.6ms
203
21409360.00Hz
-63.29dB
2.4ms
204
21409480.00Hz
-64.89dB
-0.4ms
```

Note: The MS560J must be set as a controller. For details, refer to "Procedure for controller setting" in paragraph 3.3.3. For DLI, refer to "DLI command" in paragraph 7.1.3.

8.2 Programming Techniques

Note the following writing programs for MS560J Network/Spectrum Analyzer control.

```
10 WRITE @101:"IN"
20 WAIT DELAY 1
30 WRITE @101:"ME0CT0IT"
40 WAIT DELAY 7
 :
100 WRITE @101:"MS1"
110 WAIT DELAY .05
120 WRITE @101:"MER"
130 READ @101:ME
140 IF ME=1 THEN 120
150 WRITE @101:"MMR0,251"
 :
```

10 WRITE @101: "IN"

Turn the MS560J power on. Initialize all functions to power on condition and modify the required functions with a control message to avoid setting unrequired functions.

20 WAIT DELAY 1

It takes about 1 second for the MS560J to reach power-on status.

30 WRITE @101: "ME0CT0IT"

About 15 minutes after power-up, the INTERNAL CAL. function executes for about 7 seconds. During this time, control messages are ignored. Therefore, set the INTERNAL CAL. TIMER to 0 minute (CT0) and execute it during the beginning of the program. After this, INTERNAL CAL. is not executed until IT is executed. Stop measurement (ME0) since INTERNAL CAL. is executed when measurement (sweep) stops or is terminated.

100 WRITE @101: "MS1"

Start in single sweep clarifies the relationship between measurement and data in the measurement memory.

110 WAIT DELAY 0.05

After start-up, the MS560J waits 50 ms before reading the measurement ermination status. If the MS560J reads the measurement termination status in less than 50 ms after the start-up, it may read the old status.

8.3 Program for Measuring a 21.4 MHz Intermediate Frequency Filter

This program obtains the minimum loss, 3 dB bandwidth, and center frequency of a 21.4 MHz intermediate frequency filter by magnitude measurement.

```
The Amplitude Measurement of Filter

Measurement Conditions
  1 TRACE --- MAGNITUDE
  2 CENTER --- 21.4MHz
  3 SPAN --- 30kHz
  4 RES BW --- 1kHz
  5 VIDEO BW --- 3kHz
  6 INPUT RANGE --- 0dB
  7 OUTPUT LEVEL --- 0dB
  8 SWEEP TIME --- 1.1sec
```

Fig. 8-1 Measurement Conditions

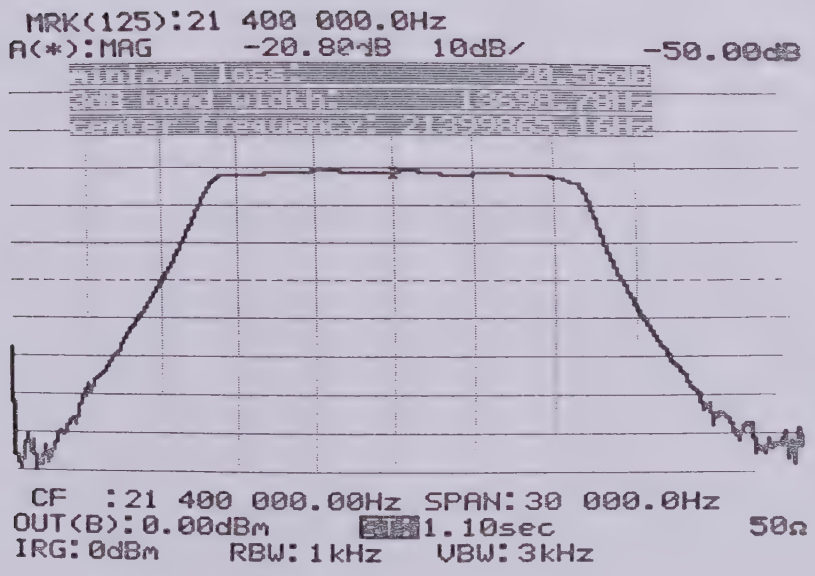
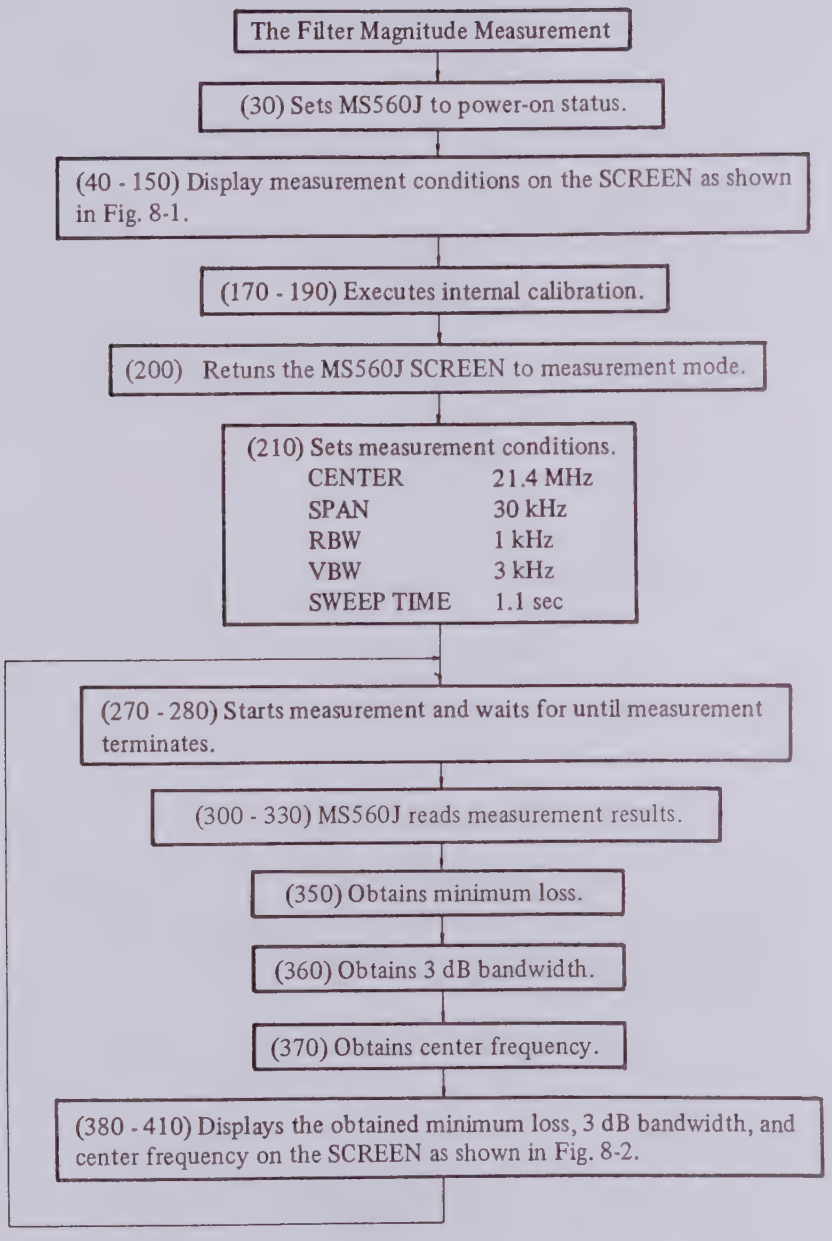


Fig. 8-2 SCREEN Display

(1) Flowchart



Note 1: The numbers in parentheses are program line numbers.

Note 2: INTERNAL CAL. is executed about 15 minutes after power on. Since control messages are ignored during INTERNAL CAL. execution, execute INTERNAL CAL. forcibly with IT by setting the timer to OFF with CT0.

(2) Program List

```
10 REM "Filter Measurement"
20 DIM FREQ(251),MAG(251)
30 WRITE @101:"IN"
40 WRITE @101:"CR0"
50 WRITE @101:"CC1,0,185,Example Program :,"
60 WRITE @101:"CC0,5,170,The Amplitude Measurement of Filter,"
70 WRITE @101:"CC3,0,145,Measurement Conditions:,"
80 WRITE @101:"CC2,20,130,1 TRACE --- MAGNITUDE,"
90 WRITE @101:"CC2,20,120,2 CENTER --- 21.4MHz,"
100 WRITE @101:"CC2,20,110,3 SPAN --- 30kHz,"
110 WRITE @101:"CC2,20,100,4 RES BW --- 1kHz,"
120 WRITE @101:"CC2,20,90,5 VIDEO BW --- 3kHz,"
130 WRITE @101:"CC2,20,80,6 INPUT RANGE --- 0dBm,"
140 WRITE @101:"CC2,20,70,7 OUTPUT LEVEL --- 0dBm,"
150 WRITE @101:"CC2,20,60,8 SWEEP TIME --- 1.1sec,"
160 REM "start internal Calibration"
170 WRITE @101:"CT0IT"¥WAIT DELAY 10
180 WRITE @101:"ITR"
190 READ @101:CAL¥IF CAL=1 THEN 180
200 WRITE @101:"CR0"¥WRITE @101:"CR9"
210 WRITE @101:"FC21400000,30000BW6,7ST1100"
220 LET FREQ(0)=21385000¥LET FSTEP=120
230 FOR I=1 TO 250
240 LET FREQ(I)=FREQ(I-1)+FSTEP
250 NEXT I
260 REM "measure"
270 WRITE @101:"MS1"¥WAIT DELAY .1
280 WRITE @101:"MER"¥READ @101:ME¥IF ME=1 THEN 280
290 REM "read measurement data"
300 WRITE @101:"MMR0,251"
310 FOR I=0 TO 250
320 READ @101:MAG(I)
330 NEXT I
340 REM "data Processing"
350 GO SUB 1000
360 GO SUB 1200
370 GO SUB 1400
380 REM "display Processing data"
390 WRITE @101 USING "C,F7.2,C":"CC3,20,188,minimum loss:          ",MIN,"dB,"
400 WRITE @101 USING "C,F11.2,C":"CC3,20,178,3dB band width:   ",BAND,"Hz,"
410 WRITE @101 USING "C,F11.2,C":"CC3,20,168,center frequency: ",CENT,"Hz,"
420 INPUT PROMPT "next measurement ?":A$
430 GO TO 260
```

```
1000 REM "minimum loss"
1010 LET MIN=-200
1020 FOR I=0 TO 250
1030 IF MAG(I)<MIN THEN 1050
1040 LET PMIN=I¥LET MIN=MAG(I)
1050 NEXT I
1060 LET MIN=MIN*(-1)
1070 RETURN
1200 REM "3dB band width"
1210 LET LSTD=MIN*(-1)-3
1220 FOR I=PMIN TO 0 STEP -1
1230 IF MAG(I)<LSTD THEN 1250
1240 NEXT I
1250 LET P0=I
1260 FOR I=PMIN TO 250
1270 IF MAG(I)<LSTD THEN 1290
1280 NEXT I
1290 LET P1=I-1
1300 LET FQL=FREQ(P0)+(FREQ(P0+1)-FREQ(P0))*(MAG(P0)-LSTD)/(MAG(P0)-MAG(P0+1))
1310 LET FQH=FREQ(P1)+(FREQ(P1+1)-FREQ(P1))*(MAG(P1)-LSTD)/(MAG(P1)-MAG(P1+1))
1320 LET BAND=FQH-FQL
1330 RETURN
1400 REM "center frequecy"
1410 LET CENT=FQL+BAND/2
1420 RETURN
1430 END
```

8.4 Program for Rapid Measurement by Decreasing Measurement Points

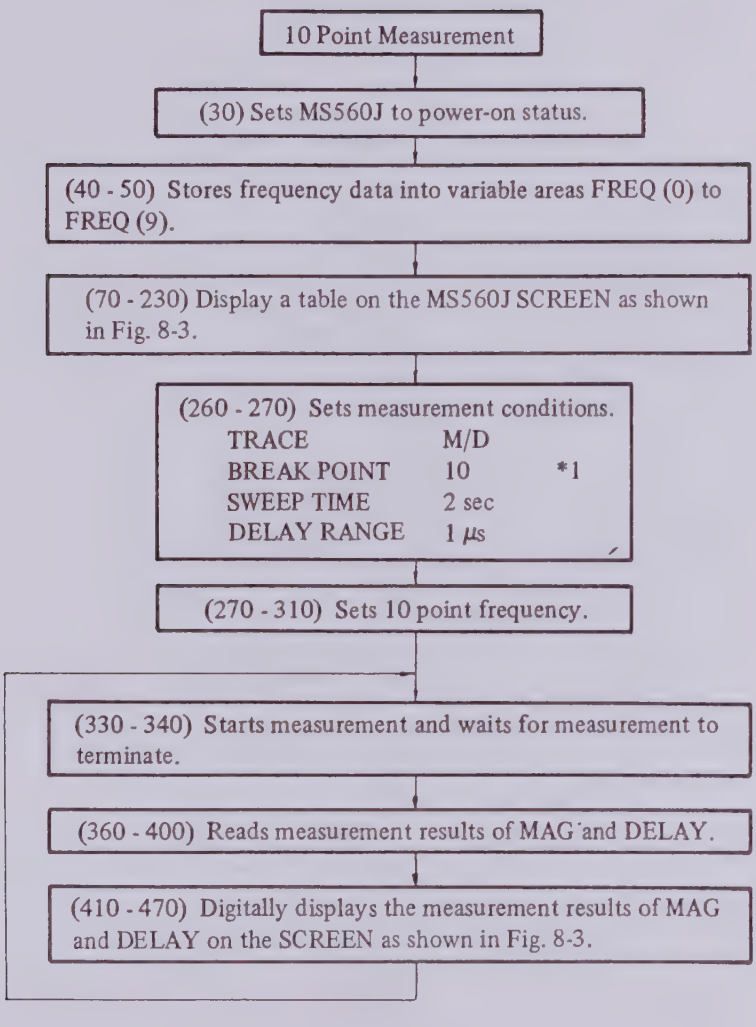
This program measures 10 points of magnitude and delay, and displays them on the screen as shown in Figure 8-3.

MEASUREMENT

FREQENCY (MHz)	MAG (dB)	DELAY(range:1us) (ns)
1.0	-91.32	160
1.1	-92.12	72
1.2	-89.81	161
1.3	-88.98	-267
1.4	-90.54	132
1.5	-89.83	14
1.6	-91.77	-249
1.7	-92.09	548
1.8	-87.67	159
1.9	-90.00	368

Fig. 8-3 Digital display of 10 point measurement

(1) Flowchart



Note 1: The number in parentheses indicates the program number.

*Note 2: *1 BREAK POINT indicates the measurement point of sweep termination.*

o Control message

BRI l: 1 ~ 251

(If l is set to 252 to 255, the current sweep status is returned to the normal sweep mode.)

o Data request message

BPR

(2) Program List

```
 10 REM "the amplitude & delay measurement of 10 point"
 20 DIM FREQ(9),MAG(9),DLY(9)
 30 WRITE @101:"IN"
 40 MAT READ FREQ
 50 DATA 1,1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9
 60 REM "control MS560J CRT"
 70 WRITE @101:"CR0"
 80 WRITE @101:"CC1,0,206,10 POINTS MEASUREMENT,"
 90 WRITE @101:"CC0,0,180, FREQENCY    MAG    DELAY(range:1us),"
100 WRITE @101:"CC0,0,168,  (MHz)      (dB)    (ns),"
110 LET Y=155
120 FOR I=0 TO 9
130 WRITE @101 USING "C,A,C,F4.1,C":"CC0,10,",Y,",",FREQ(I),","
140 LET Y=Y-15
150 NEXT I
160 WRITE @101:"CG1,2,193,220,193"
170 FOR Y=166 TO 10 STEP -15
180 WRITE @101 USING "C,A":"CG1,2,",Y,",220,",Y
190 NEXT Y
200 WRITE @101:"CG1,2,16,2,193"
210 WRITE @101:"CG1,60,16,60,193"
220 WRITE @101:"CG1,110,16,110,193"
230 WRITE @101:"CG1,220,16,220,193"
240 REM "set measurement conditions"
250 WRITE @101:"ME1CT0IT"¥WAIT DELAY 10
260 WRITE @101:"TR7BF10ST2000"
270 WRITE @101:"DR0F00"
280 REM "store in frequency memory"
290 FOR I=0 TO 9
300 WRITE @101 USING "A":FREQ(I)¥1000000
310 NEXT I
320 REM "measure start/end"
330 WRITE @101:"MS1"¥WAIT DELAY .05
340 WRITE @101:"MER"¥READ @101:ME¥IF ME=1 THEN 340
350 REM "read amplitude & delay"
360 WRITE @101:"MMR0,10"
370 FOR I=0 TO 9
380 READ @101:MAG(I)
390 READ @101:DLY(I)
400 NEXT I
410 LET Y=155
420 REM "Print amplitude & delay"
430 FOR I=0 TO 9
440 WRITE @101 USING "C,A,C,F7.2,C":"CC0,60,",Y,",",MAG(I),","
450 WRITE @101 USING "C,A,C,F5.0,C":"CC0,130,",Y,",",DLY(I),","
460 LET Y=Y-15
470 NEXT I
480 GO TO 330
490 END
```

8.5 Program for Measuring Input Signal Frequency and Level

This program measures the frequency and level of approx. 10 MHz input signal.

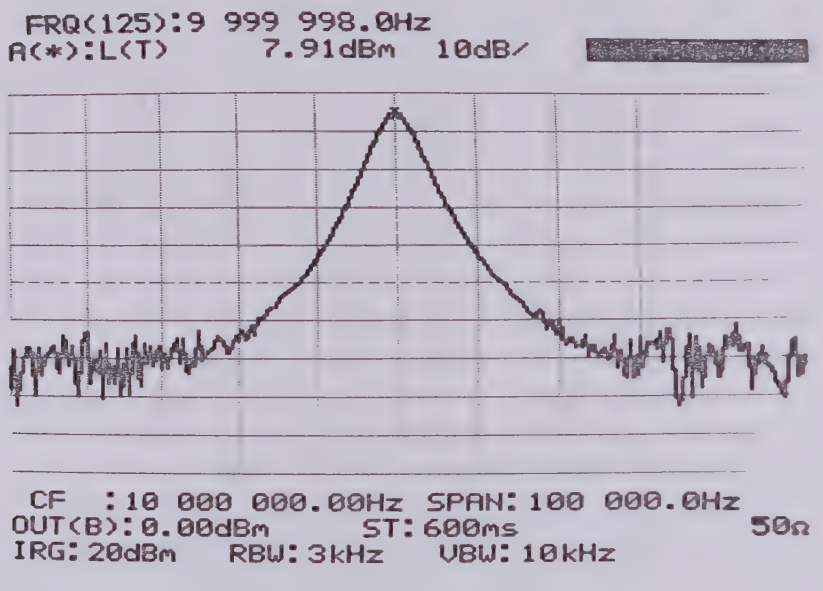
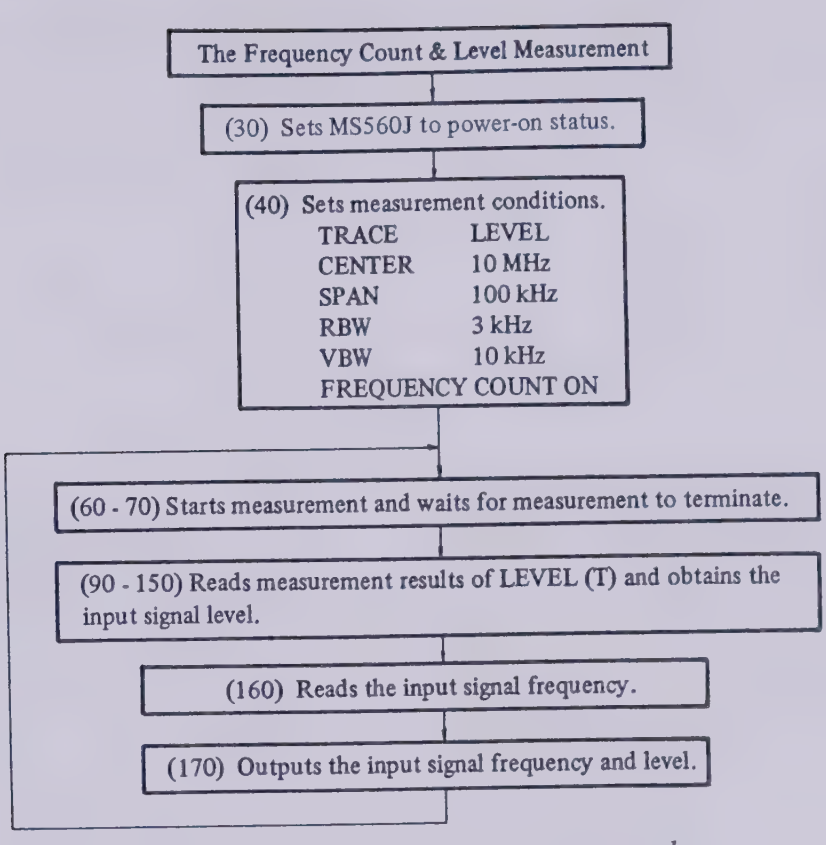


Fig. 8-4 MS560J SCREEN during frequency measurement

Note: Since the frequency is measured after the sweep is terminated, read the measurement value of the frequency (MFR) about 1.5 seconds after sweep termination.

(1) Flowchart



Note: The value in parentheses indicates the program number.

(2) Program list

(A)

```
 10 REM "the frequency count & level measurement"
 20 REM "set measurement conditions"
 30 WRITE @101:"IN"
 40 WRITE @101:"TR4FC10000000,100000BW7,8FO1"
 50 REM"measure start/end"
 60 WRITE @101:"MS1"¥WAIT DELAY .5
 70 WRITE @101:"MER"¥READ @101:MC¥IF MC=1 THEN 70
 80 REM"read frequency & level"
 90 WRITE @101:"MMR0,251"
100 LET LEVEL=-200
110 FOR I=0 TO 250
120 READ @101:LVLT
130 IF LVLT<LEVEL THEN 150
140 LET LEVEL=LVLT
150 NEXT I
160 WRITE @101:"MFR"¥READ @101:FREQ
170 PRINT FREQ;"Hz",LEVEL;"dBm"
180 GO TO 50
190 END
```

8.6 FREQUENCY OFFSET TRACKING

Connecting the MS560J to any of the following synthesizers through the GP-IB allows tracking by frequency shifting. This function is used to test devices such as mixers that have difference input and output frequencies.

Synthesizers:

- MS443B (Anritsu)
- MG545[ ] (Anritsu)
- MG440[ ] (Anritsu)
- 178 (Wavetek)
- 3336 (Hewlett Packard)

(1) Synthesizer Control Format:

These formats are set using the ADV FUNCTION.

11 WRITE [#] ○ , ○ [EOL]

Format

Synthesizer's GP-IB address

(a) Format "A" . . . . . for MG440A/K, MG545A/K, or MG443B in only mode.

(b) Format "B" . . . . . for MG440C/M or MG545C/M

(c) Format "C" . . . . . for Wavetek 178

(d) Format "D" . . . . . for MG443B

FQ ○○○○○○○○ (CR)(LF)

(e) Format "E" . . . . . for HP3336

FF ○○○○○ . ○○ HZ (CR)(LF)

(f) Format "F" . . . . . for MG443B in high speed mode

Special format

Note: Format "F" cannot be used at logarithmic frequency sweep.

(2) Connection

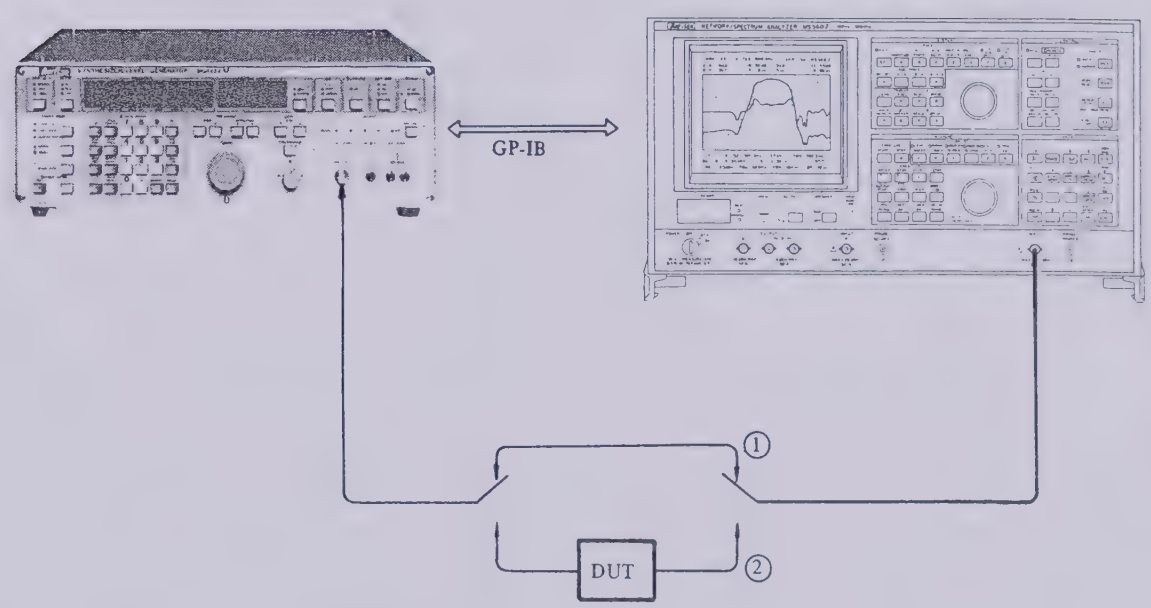
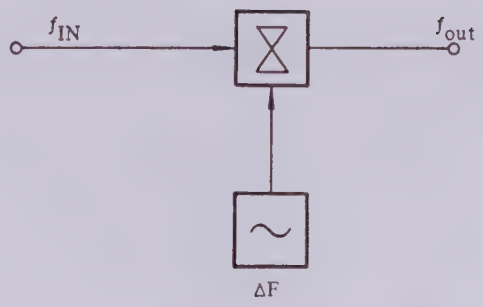


Fig. 8-5 Connections

(3) Frequency Conversion System

Any one of the three modes shown in Fig. 8-6 can be selected with the frequency conversion system.



MODE	Conversion system
0	f_{out} : $f_{IN} + \Delta F$ • $f_{out} \leqq 30$ MHz
1	f_{out} : $f_{IN} - \Delta F$ • $f_{IN} > \Delta F$ • $f_{out} \leqq 30$ MHz • f_{IN}: 10 Hz to 500 MHz
2	f_{out} : $\Delta F - f_{IN}$ • $\Delta F > f_{IN}$ • $f_{out} \leqq 30$ MHz • f_{IN}: 10 Hz to 500 MHz

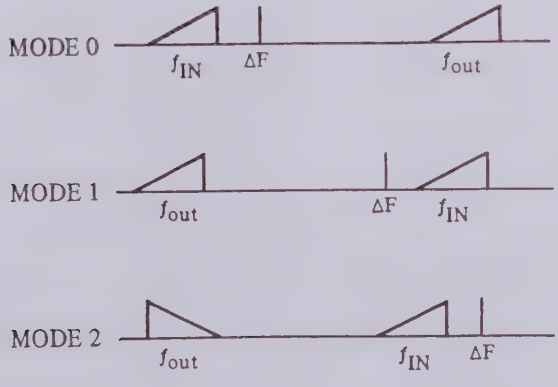


Fig. 8-6 Frequency Conversion System

(4) GP-IB MESSAGE

The following control messages and data request messages have been added.

(a) Frequency sweep mode

- Control message

FPn

n = 0 : LOG START/STOP
1 : START/STOP
2 : CF/SPAN

- Data request message

FPR

(b) SAVE FUNCTION

- Control message

SV1, 7

Trace conditions on the CRT are saved to the PBM.

(c) RECALL FUNCTION

- Control message

RC1, 7

Trace conditions saved in the PBM are displayed on the CRT in low-intensity mode.

RC1, 8

The low-intensity screen is erased and replaced by a scale line.

RC0, 3

The offset is automatically set to the marker readout value.

RC0, 4

SPAN is automatically set to the frequencies pointed by the two markers.

RC0, 5

The center frequency is automatically set to the main marker frequency.

RC0, 6

The main marker is automatically set to the top of trace-A.

RC0, 9

The MS560J is initialized when the power is turned on.

(4) Offset tracking

- Mode and ΔF

FTm, ℓ

m = 0 to 2 : mode
ℓ = 0 to 1000 000 000 .00 : ΔF

- Format

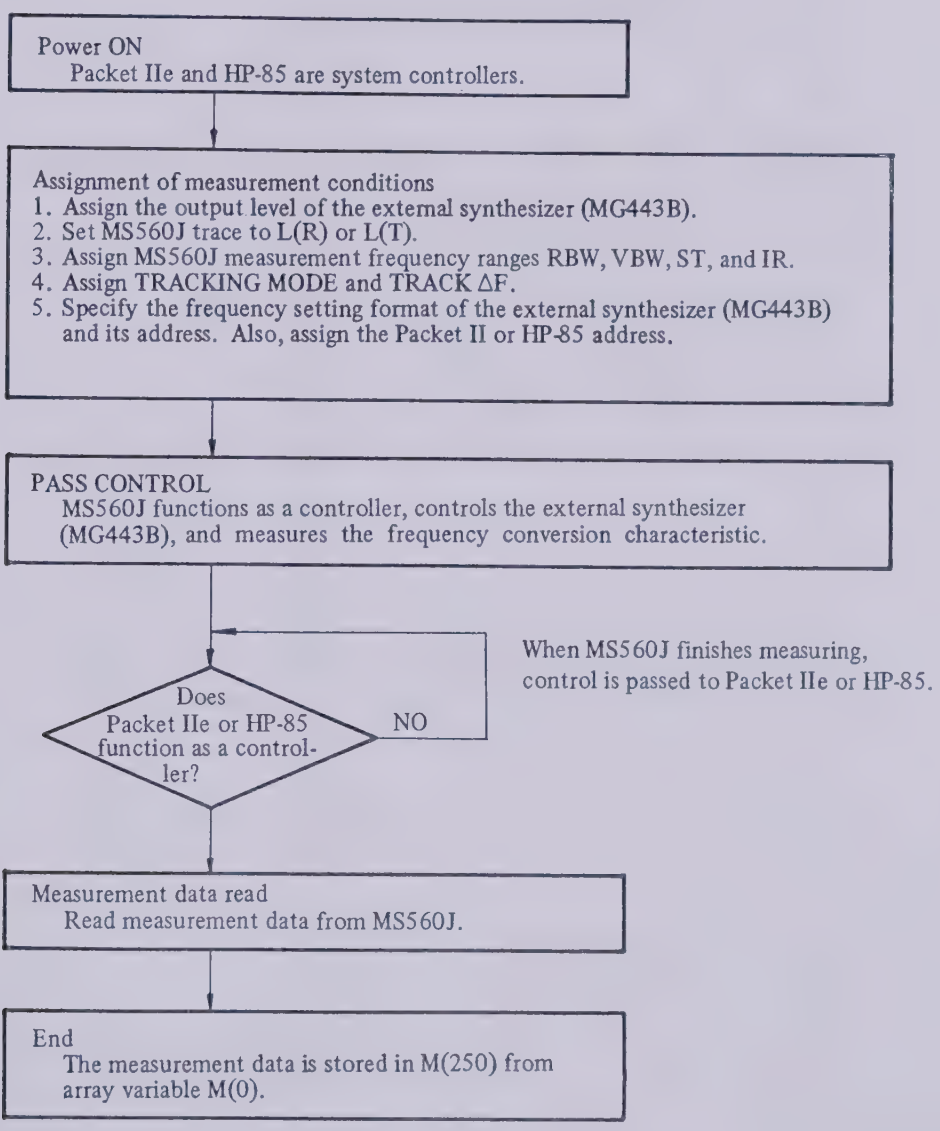
WTm0, m1, m2

m0 = A to F : Synthesizer's model
(See paragraph 8.6.(1))
m1 = Synthesizer's address
m2 = Controller's address

(5) FREQUENCY CONVERSION CHARACTERISTIC MEASUREMENT PROGRAM

Packet IIe and HP-85 program examples are described.

(a) Flowchart



(b) Packet IIe Program Example

```
 10 REM "measurement of frequency offset tracking"
 20 REM "MS560J uses Pass control function"
 30 DIM M(250)
 40 COM CFLAG
 50 LET MS560=101¥LET MG443=102
 60 WRITE @MS560:"IN"¥WAIT DELAY 1
 70 !
 80 !
 90 !
100 REM "set measurement conditions"
110 WRITE @MG443:"LV-20.00"!MG443A output level =-20.00dBm
120 WRITE @MG560:"TR4"!TRACE is L(T)
130 WRITE @MG560:"FS10000,20000BW6,7ST4000IR2"
140 !start frequency is 10kHz,stop frequency is 20kHz
150 !resolution BW is 1kHz,video BW is 3kHz
160 !sweep time is 4sec,input range is -20dBm
170 WRITE @MS560:"FT0,12000"
180 !TRACKING MODE is 0,TRACK ^F is 12kHz
190 WRITE @MG560:"WTD,2,20"
200 !tracking format is D,MG443B address is 2,Packet address is 20
210 !
220 !
230 !
240 !
250 !
260 REM "Process GP-IB interrupt"
270 PROCESS EVENT GPIB"@01,00"!interrupt by becoming controller
280 START PASSCONTROL
290 CONNECT EVENT GPIB
300 REM "PASS CONTROL"
310 LET CFLAG=1¥PCT @MS560
320 IF CFLAG=1 THEN 320! ? Packet becomes controller
330 !
340 !
350 !
360 REM "read measurement data"
370 WRITE @MG560:"MMR0,251"
380 MAT READ @MS560 USING "F9":M
390 !
400 GO TO 300
410 !
420 !
430 END
440 !
450 !
460 !
1000 PARACT PASSCONTROL URGENCY 70
1010 COM CFLAG
1020 WAIT EVENT GPIB
1030 LET CFLAG=0
1040 GO TO 1020
1050 END PARACT
1060 !
1070 !
1080 !
```

(c) HP-85 Program Example

The data read time from MS560J is reduced using an I/O buffer memory.

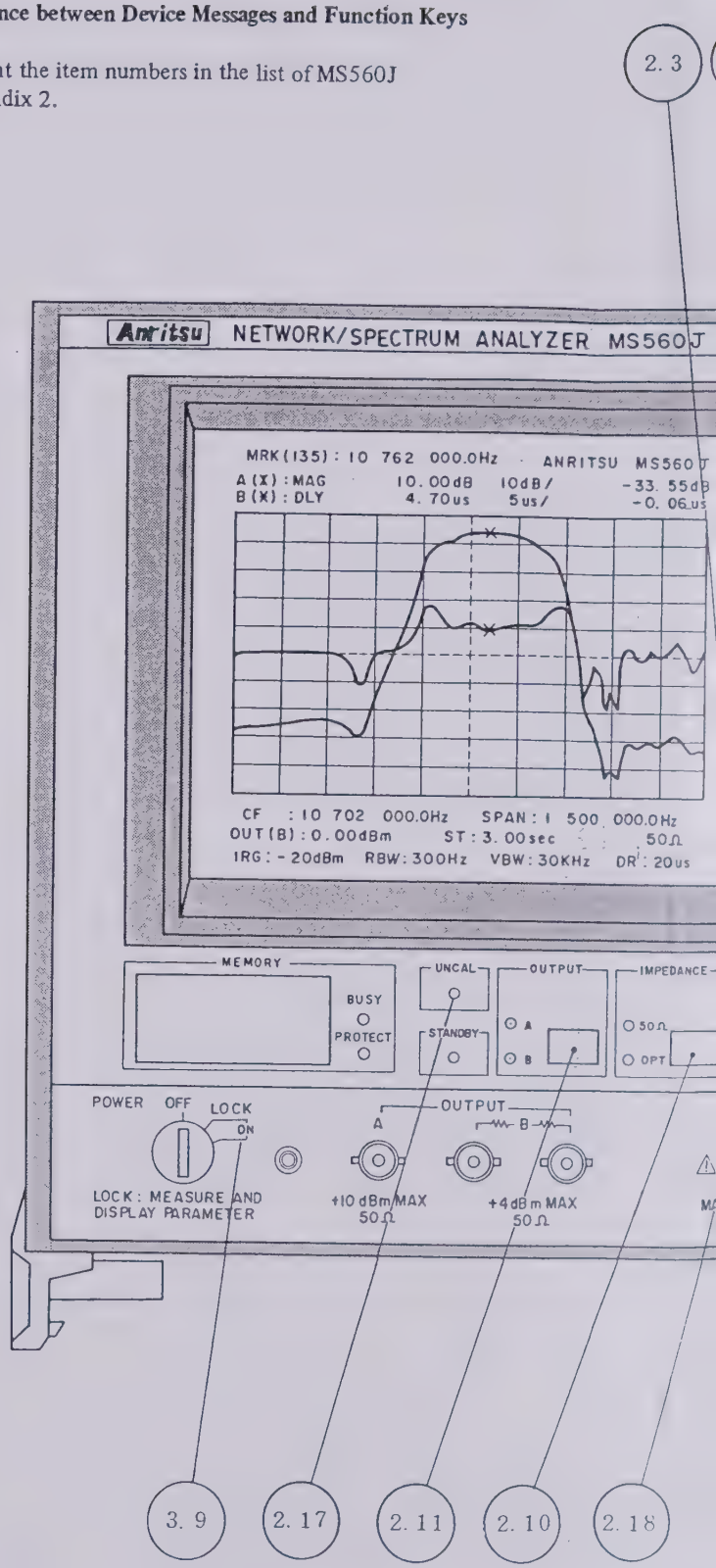
Read time when the I/O buffer memory is used: Approximately 0.5 sec.

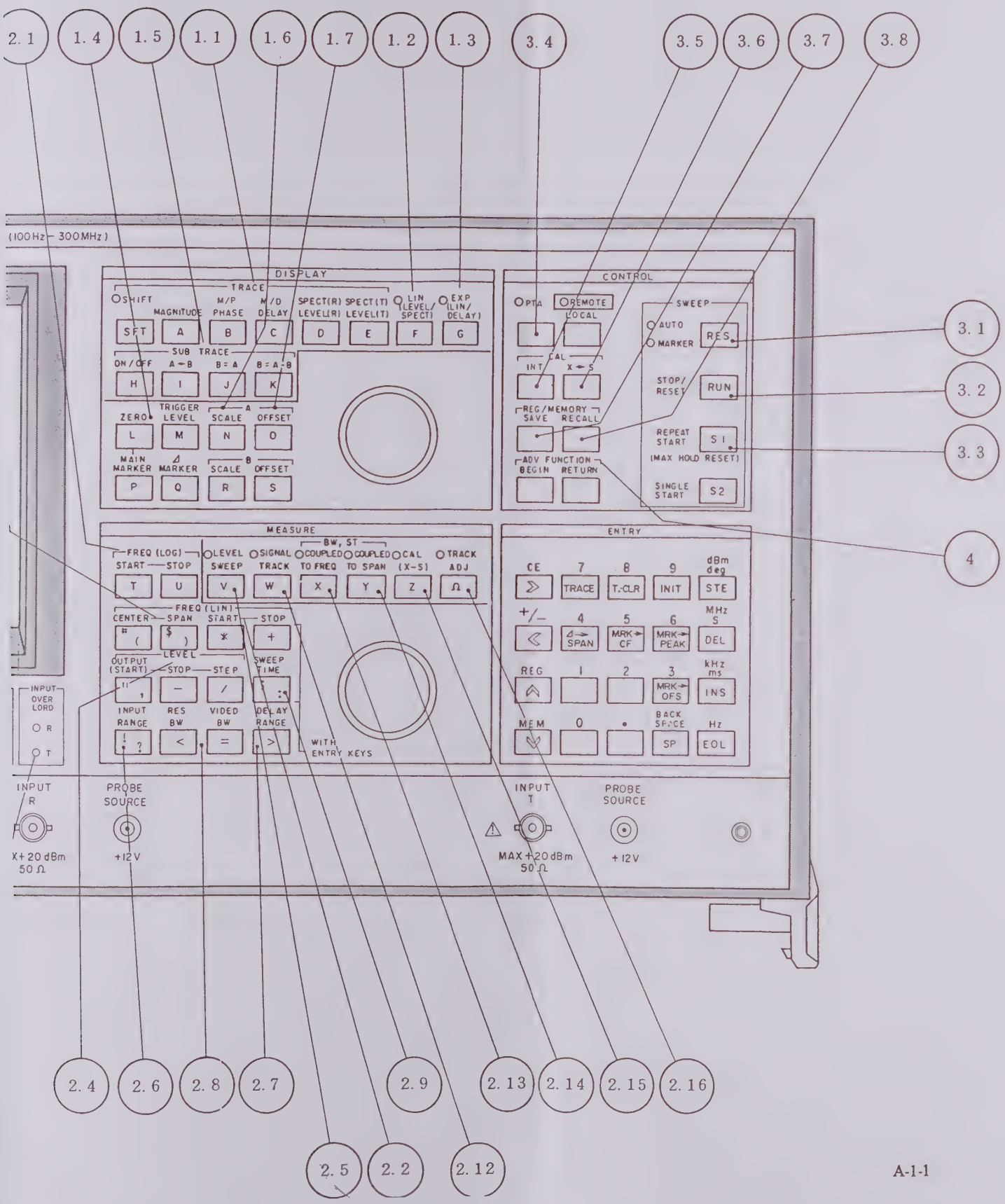
Read time when not used: Approximately 15 sec.

```
10 REM "measurement of frequenc
   yoffset tracking"
20 REM "MS560Juses pass contr
   ol function"
30 DIM M(250),Z$[2267]
40 IOBUFFER Z$
50 OUTPUT 701 ;"IN" ! set initi
   alized MS560J
60 WAIT 1000
70 !
80 !
90 !
100 REM "set measurement conditi
   ons"
110 OUTPUT 702 ;"LV-20.00" ! MG4
   43A output level =-20.00dBm
120 OUTPUT 701 ;"TR4" ! TRACE is
    L(T)
130 OUTPUT 701 ;"FS10000,20000BW
   6,7ST4000IR2"
140 ! start frequency is 10kHz,s
   top frequency is 20kHz
150 ! resolution BW is 1kHz,vide
   o BW is 3kHz
160 ! sweep time is 4sec,input r
   ange is -20dBm
170 OUTPUT 701 ;"FT0,12000"
180 ! TRACKING MODE is 0,TRACK ^
   F is 12kHz
190 OUTPUT 701 ;"WTD,2,21"
200 ! tracking format is 0,MG443
   A address is 2,HP-85 address
    is 21
210 !
220 !
230 !
240 !
250 !
260 REM "pass control"
270 PASS CONTROL 701
280 WAIT 100
290 STATUS 7,5 ; S
300 IF BIT(S,5)<>1 THEN 290
310 !
320 !
330 !
340 !
350 REM "read mesurement datas"
360 OUTPUT 701 ;"MMR0,251"
370 TRANSFER 701 TO Z$ FHS ; COU
   NT 2267
380 FOR I=0 TO 250
390 ENTER Z$ ; M(I)
400 NEXT I
410 END
```

APPENDIX 1 Correspondence between Device Messages and Function Keys

The values in circles ○ represent the item numbers in the list of MS560J device messages given as Appendix 2.



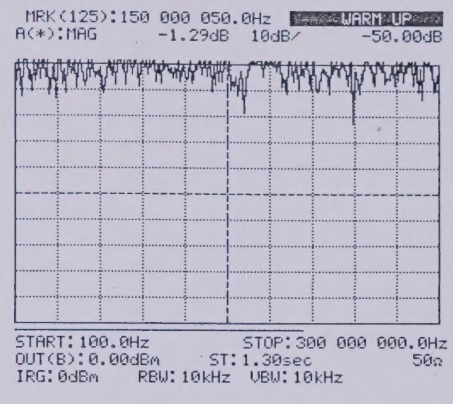

2.1
1.4
1.5
1.1
1.6
1.7
1.2
1.3
3.4
3.5
3.6
3.7
3.8
(100Hz – 300MHz)
DISPLAY
TRACE
SHIFT
MAGNITUDE
M/P PHASE
M/D DELAY
SPECT(R) LEVEL(R)
SPECT(T) LEVEL(T)
LIN (LEVEL/SPECT)
EXP (LIN/DELAY)
SFT
A
B
C
D
E
F
G
SUB TRACE
ON/OFF
A–B
B=A
B=A–B
H
I
J
K
TRIGGER LEVEL
A SCALE
A OFFSET
ZERO
L
M
N
O
MAIN MARKER
Δ MARKER
B SCALE
B OFFSET
P
Q
R
S
CONTROL
OPTA
REMOTE
LOCAL
CAL
INT
X←S
REG/MEMORY
SAVE
RECALL
ADV FUNCTION
BEGIN
RETURN
SWEEP
AUTO
MARKER
RES
STOP/RESET
RUN
REPEAT START
S1
(MAX HOLD RESET)
SINGLE START
S2
3.1
3.2
3.3
4
MEASURE
FREQ (LOG)
START
STOP
LEVEL
SWEEP
SIGNAL TRACK
BW, ST
COUPLED TO FREQ
COUPLED TO SPAN
CAL (X–S)
TRACK ADJ
T
U
V
W
X
Y
Z
Ω
FREQ (LIN)
CENTER
SPAN
START
STOP
#
(
$
)
*
+
LEVEL
OUTPUT (START)
STOP
STEP
SWEEP TIME
!
,
–
/
;
:
INPUT RANGE
RES BW
VIDED BW
DELAY RANGE
?
<
=
>
WITH ENTRY KEYS
ENTRY
CE
7
8
9
dBm deg
TRACE
T.-CLR
INIT
STE
+/–
4
5
6
MHz S
Δ→SPAN
MRK→CF
MRK→PEAK
DEL
REG
1
2
3
kHz ms
MRK→OFS
INS
MEM
0
•
BACK SPACE
Hz
SP
EOL
INPUT OVER LORD
R
T
INPUT R
X+20dBm 50Ω
PROBE SOURCE
+12V
INPUT T
MAX+20dBm 50Ω
PROBE SOURCE
+12V
2.4
2.6
2.8
2.7
2.9
2.13
2.14
2.15
2.16
2.5
2.2
2.12

APPENDIX 2 LIST OF MS560J DEVICE MESSAGES

Item number	Function		Control message	Data request message
1.1	Display functions	TRACE	TRm	TRR
1.2		LIN/IF ATT/TRIGGER LEVEL	LIn, m, ℓ	LIR
1.3		EXP	EXn	EXR
1.4		MARKER	MKm, ℓ	MKR
1.5		SUB TRACE	AXn, m	AXR
1.6		SCALE A/B	SCm1, m2	SCR
1.7		OFFSET A/B	OFℓ1, ℓ2	OFR
2.1	Measurement functions	LOG START/STOP FREQUENCY	FLm1, m2	FLR
2.2		START/STOP FREQUENCY	FSℓ1, ℓ2	FSR
2.3		CENTER/SPAN FREQUENCY	FCℓ1, ℓ2	FCR
2.4		START (OUTPUT)/STOP/STEP LEVEL	LLℓ1, ℓ2, ℓ3	LLR
2.5		LEVEL SWEEP	LWn	LWR
2.6		INPUT RANGE	IRm	IRR
2.7		DELAY RANGE	DRm	DRR
2.8		RES/VIDEO BW	BWm1, m2	BWR
2.9		SWEEP TIME	STℓ	STR
2.10		IMPEDANCE	IMm1, m2	IMR
2.11		OUTPUT A/B	OPm	OPR
2.12		SIGNAL (AUTO) TRACK	ATn	ATR
2.13		COUPLED TO FREQ	CFn, m	CFR
2.14		COUPLED TO SPAN	CPn	CPR
2.15		CAL X–S	XSn	XSR
2.16		TRACK ADJ	BTn, ℓ	BTR
2.17		UNCAL		UCR
2.18		OVER LOAD		OVR
3.1	Control functions	SWEEP AUTO/MARKER	AMn	AMR
3.2		SWEEP STOP/RESET	MEm	MER
3.3		SWEEP REPEAT/SINGLE START	MSm	
3.4		PTA (OPTION 01)	PTn	PTR
3.5		INTERNAL CAL	IT	
3.6		X→S CAL	CS	
3.7		SAVE	SVm1, m2	
3.8		RECALL	RCm1, m21	
3.9		INITIAL SET	IN	
4.1	Advance functions	INTEGRATING	IGn	IGR
4.2		MAX. HOLD	MHn	MHR
4.3		FREQUENCY COUNT	FOn	FOR
4.4		SWEEP MARKER	SMn	SMR
4.5		BUZZER	BZn	BZR
4.6		AUTO CAL. TIMER	CTℓ	CTR
4.7		TITLE	TT, abc,	TTR
4.8		SRQ	SQn	SQR
4.9		DELIMIT	DMn	DMR
4.10		SEND		SDR
5.1	Measurement data	FREQUENCY MEMORY	FQℓ	FRQℓ1, ℓ2
5.2		LEVEL MEMORY	LVℓ	LVRℓ1, ℓ2
5.3		Measurement memory for channel A	XAℓ	XARℓ1, ℓ2
5.4		Measurement memory for channel B	XBℓ	XBRℓ1, ℓ2
5.5		S memory for channel A	SAℓ	SARℓ1, ℓ2
5.6		S memory for channel B	SBℓ	SBRℓ1, ℓ2
5.7		Reading measurement results		MMRℓ1, ℓ2
6.1	CRT	Display deletion	CRm	
6.2		Character display	CCm, X, Y	
6.3		Graphic display	CGm, X1, Y1, X2, Y2	

APPENDIX 3 FRONT PANEL STATUS AT POWER-ON

(1) SCREEN display



(2) Function

LIN --- OFF
EXP --- OFF

TRACE	SCALE	OFFSET
PHASE	50 deg/	0 deg
DELAY	10 ms/	0 ms
L(R), S(R)	10 dB/	−50 dBm
L(T), S(T)	10 dB/	−50 dBm

FREQ (LOG)

START --- 100 Hz
STOP --- 300 MHz

FREQ (LIN)

CENTER --- 150000000.0 Hz
SPAN --- 300000000.0 Hz

LEVEL

OUT (START) --- 0 dBm
STOP --- 9 dBm
STEP --- 1 dB

DELAY RANGE --- 40 mS
LEVEL SWEEP --- OFF
SIGNAL TRACK --- OFF
COUPLED TO FREQ --- OFF
COUPLED TO SPAN --- OFF
CAL (X-S) --- OFF
TRACK ADJ --- OFF
SWEEP

AUTO/MARKER --- AUTO
REPEAT --- ON

ADV FUNCTION

INTEGRATING --- OFF
MAX HOLD --- OFF
FREQ COUNT --- OFF
TRACKING ΔF --- 0 Hz
TRACKING MODE --- 0
AUTO CAL TIME --- 0
SWEEP MARKER --- ON
BUZZER --- ON

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